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TECHNICAL MANUAL

OPERATOR'S AND ORGANIZATIONAL MAINTENANCE MANUAL DOPPLER NAVIGATION SET AN/ASN-128 (NSN 5841-01-064-9738)

This copy is a reprint which includes current
pages from Changes 1 and 2.

HEADQUARTERS, DEPARTMENT OF THE ARMY

11-11-11



CHANGE }
No. 2 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 1 April, 1982

Operator's And Organizational Maintenance Manual
DOPPLER NAVIGATION SET AN/ASN-128
(NSN 5841-01-064-9738)

TM 11-5841-281-12, 30 May 1979, is changed as follows:

1. New or changed material is indicated by a vertical bar in margin.
2. Added or revised illustrations are indicated by a vertical bar next to the figure caption.
3. Remove old pages and insert new pages as indicated below:

<i>Remove Pages</i>	<i>Insert Pages</i>
None	A and B (front of manual)
i and II	i, ii, and iii
1-5 through 1-7	1-5 through 1-15
3-3 through 3-10	3-3 through 3-10
4-1 through 4-3	4-1 through 4-3/(4- 4 blank)
5-1 through 5-9	5-1 through 5-9/(5-10 blank)

4. File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army:

Official:

ROBERT M. JOYCE
Brigadier General, United States Army
The Adjutant General

E. C. MEYER
General, United States Army
Chief of Staff

Distribution:

To be distributed in accordance with DA Dorm 12-31, Operator's Maintenance requirements for UH-60A Aircraft.

Change }
No. 1 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 5 June 1981

**Operator's and Organizational Maintenance Manual
DOPPLER NAVIGATION SET AN/ASN-128 (NSN 5841-01-064-9738)**

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1. Remove old pages and insert new pages as indicated below.
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Remove pages

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i and ii	i and ii
1-1 and 1-2	1-1 and 1-2
1-5 and 1-6	1-5 and 1-6
2-1 and 2-2	2-1 and 2-2
2-5 and 2-6	2-5 and 2-6
5-5 and 5-6	5-5 and 5-6

3. File this change sheet in front of the manual for reference purposes.

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Official:

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General, United States Army
Chief of Staff

J. C. PENNINGTON
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-31 Operator maintenance requirements for UH-60A aircraft.

**5**

**SAFETY STEPS TO FOLLOW IF SOMEONE
IS THE VICTIM OF ELECTRICAL SHOCK**

1

DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL

2

IF POSSIBLE , TURN OFF THE ELECTRICAL POWER

3

**IF YOU CANNOT TURN OFF THE ELECTRICAL
POWER, PULL, PUSH, OR LIFT THE PERSON TO
SAFETY USING A WOODEN POLE OR A ROPE OR
SOME OTHER INSULATING MATERIAL**

4

SEND FOR HELP AS SOON AS POSSIBLE

5

**AFTER THE INJURED PERSON IS FREE OF
CONTACT WITH THE SOURCE OF ELECTRICAL
SHOCK, MOVE THE PERSON A SHORT DISTANCE
AWAY AND IMMEDIATELY START ARTIFICIAL
RESUSCITATION**

WARNING



HIGH VOLTAGE

is used in the operation of this equipment

DEATH ON CONTACT

may result if personnel fail to observe safety precautions

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When the technician is aided by operators, he must warn them about dangerous areas.

Whenever possible, the power supply to the equipment must be shut off before beginning work on the equipment. Take particular care to ground every capacitor likely to hold a dangerous potential. When working inside the equipment, after the power has been turned off, always ground every part before touching it.

Be careful not to contact high-voltage connections or 115 volt ac input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through the body.

Warning: Do not be misled by the term "low voltage." Potentials as low as 50 volts may cause death under adverse conditions.

For Artificial Respiration, refer to FM 21-11.

OPERATOR'S AND ORGANIZATIONAL MAINTENANCE MANUAL
DOPPLER NAVIGATION SET AN/ASN-128
(NSN 5841-01-064-9738)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS
You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: DRSEL-ME-MQ, Fort Monmouth, NJ 07703.
In either case, a reply will be furnished direct to you.

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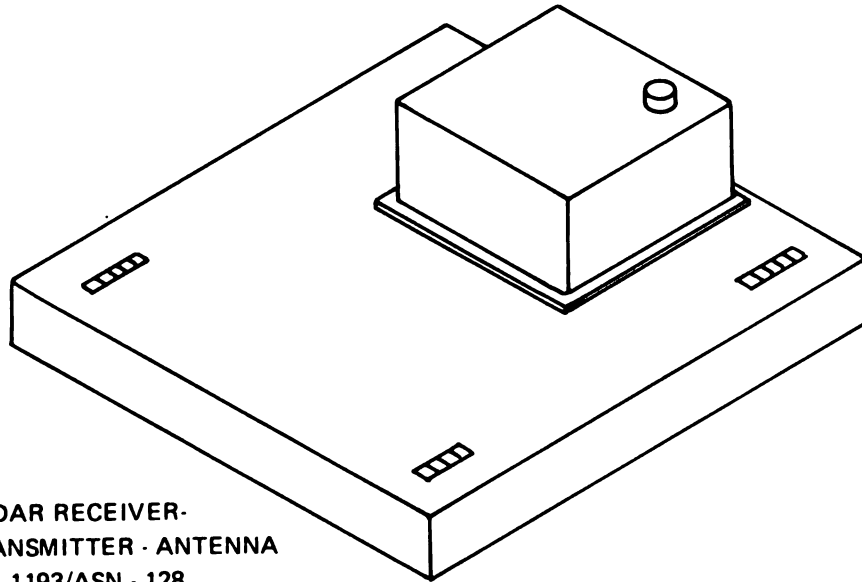
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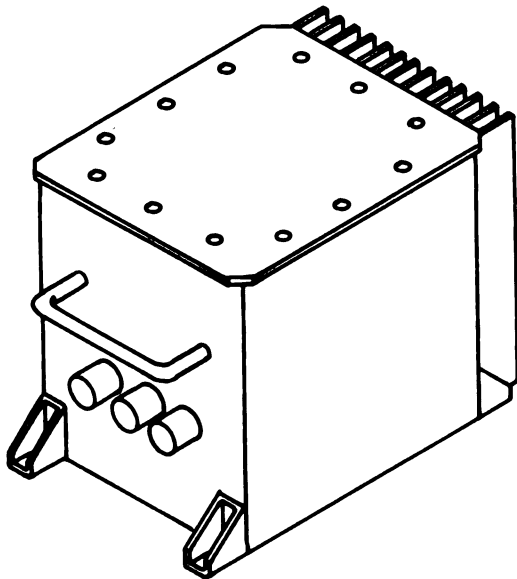
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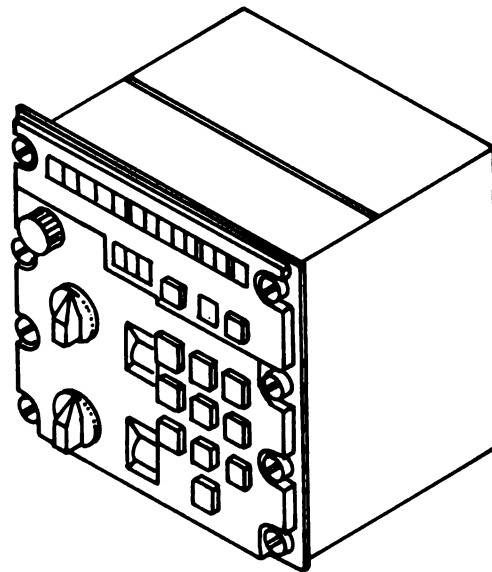
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RADAR RECEIVER-
TRANSMITTER - ANTENNA
RT - 1193/ASN - 128
(UNIT 2)



RADAR SIGNAL DATA CONVERTER
CV - 3338/ASN - 128
(UNIT 1)



COMPUTER DISPLAY UNIT
CP - 1252/ASN - 128
(UNIT 3)

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Figure 1-1. Doppler Navigation Set AN/ASN-128

CHAPTER 1 INTRODUCTION

Section 1. GENERAL

1-1. Scope

a. This manual describes operator and organizational maintenance (aviation unit maintenance (AVUM)) of Doppler Navigation Set AN/ASN-128 (navigation set) (fig. 1-1), and includes installation, operation, and operator and organizational maintenance (AVUM) of the navigation set. Organizational maintenance (AVUM) includes cleaning, preventive maintenance checks and services, troubleshooting, and replacement procedures for parts authorized at the organizational maintenance. Operation instructions include a description of the controls and indicators used by the operator, and operation under usual and unusual conditions.

b. Refer to TM 11-5841-281-20P for repair parts and special tools authorized at the organizational maintenance (AVUM).

c. The navigation set is covered under a manufacturer's Reliability Improvement Warranty (RIW) contact. The Government shall verify failures prior to the return of units to the manufacturer, provide data and failure data and use appropriate packing and packaging when returning the equipment under RIW to the manufacturer.

1-2. Indexes of Publications

Refer to the latest issue of DA PAM 310-4 to determine whether there are new editions, changes, additional publications or modification work orders pertaining to the equipment.

1-3. Maintenance Forms, Records, and Reports

a. *Reports of Maintenance and Unsatisfactory Equipment.* Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 38-750, The Army Maintenance Management System (Army). Navy personnel will report maintenance performed utilizing the Maintenance Data Collection Subsystem (MDCS) IAW OPNAVINST 4790.2, Vol 3 and unsatisfactory material/conditions (UR submissions) IAW OPNAVINST 4790.2, Vol 2, chapter 17.

b. *Report of Item and Packaging Discrepancies.* Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/NAVMATINST 4355.73/AFR 400-54/MCO 4430.3E.

c. *Discrepancy in Shipment Report (DISREP) (SF 361).* Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33B/AFR 75-18/MCO P4610.19C and DLAR 4500.15.

d. *Reporting Equipment Improvement Recommendations (EIR).*

(1) *Army.* If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design. Tell us why a procedure is hard to perform. Put it on an SF 368 (Quality Deficiency Report). Mail it to Commander, US Army Communication and Electronics Materiel Readiness command, ATTN: DRSEL-ME-MQ, Fort Monmouth, 07703. We'll send you a reply.

(2) *Navy.* Navy personnel are encouraged to submit EIR's through their local Beneficial Suggestion Program.

e. *(Army Only) Destruction of Army Materiel to Prevent Enemy Use.* Demolition of this set will be accomplished only upon the order of the Commander. Refer to TM 750-244-2 for procedures to prevent the enemy from using or salvaging this equipment.

f. *(Army Only) Administrative Storage.* Administrative storage of equipment issued to and used by Army activities shall be maintained in a maximum Readiness Condition (REDCON). Equipment placed in administrative storage should be capable of being readied to perform its mission within a 24 hour period or as otherwise prescribed by the approving authority. Before equipment is placed in administrative storage, current maintenance service should be performed; shortcomings and deficiencies should be corrected; and all modification work orders (MWO's) as listed in DA Pam 310-4 should be applied. Particular attention is directed to security and calibration of installed electronic equipments in or out of aircraft or surface equipment prior and during administrative storage. Special procedures include protection from dust and humidity and the cleanliness and inspection of the electronic equipments. Upon removal from storage, the electronic equipments must be prepared for operation and tested in accordance with the PMCS charts and procedure: in pertinent technical manuals.

1-4. Destruction of Army Electronics Materiel—Deleted.

1-5. Administrative Storage—Deleted.

1-6. Reporting Equipment Improvement Recommendations (EIR)—Deleted.

Section II. DESCRIPTION AND DATA

1-7. Purpose and Use

a. Purpose. Doppler Navigation Set AN/ASN-128 is an airborne navigational system which determines the three orthogonal components of aircraft velocity from measurements of the Doppler frequency shift, and computes present position and bearing, time, and distance to selected destinations.

b. Use. When provided with a synchro reference signal and pitch, roll, heading, true airspeed, and prime power from the aircraft, the navigation set provides the following displays:

- (1) Present position or destination in latitude and longitude or Universal Transverse Mercator (UTM) coordinates.
- (2) Groundspeed in kilometers per hour.
- (3) Track angle in degrees.
- (4) Distance crosstrack in kilometers.
- (5) Track angle error in degrees.
- (6) Windspeed in kilometers per hour.
- (7) Wind direction in degrees relative to true north.

(8) Distance to destination in kilometers and tenths of a kilometer.

(9) Bearing to selected destination in degrees.

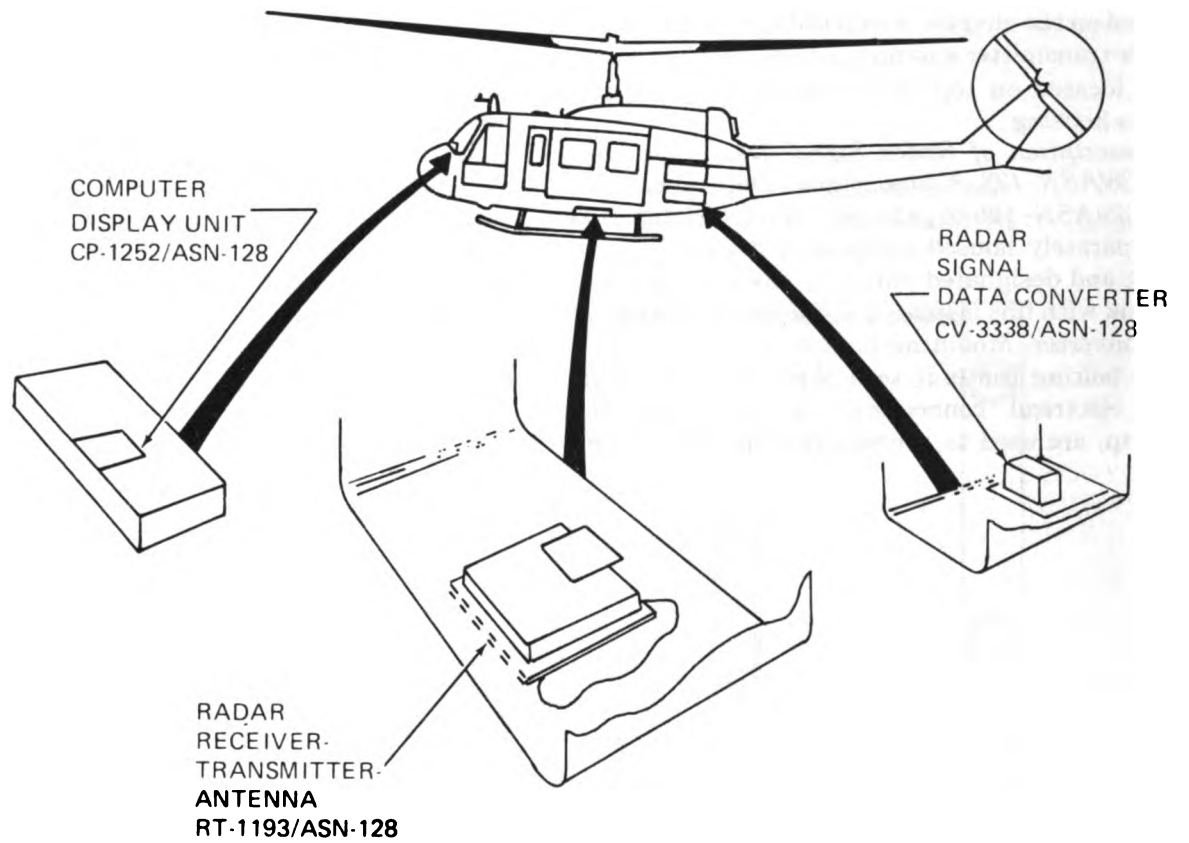
(10) Time to selected destination in minutes and tenths of a minute.

(11) Spheroid code of destination (manually set in).

(12) Magnetic variation of destination (manually set in).

1-8. Description of Doppler Navigation Set AN/ASN-128

Doppler Navigation Set AN/ASN-128 (fig. 1-1) consists of three major equipment components installed in the aircraft. The three components use convection and conduction cooling (no blowers are used), and are interconnected with multiconductor cables for transferring signals and power within the navigation set. Figure 1-2 shows the locations of the components for a typical aircraft installation.



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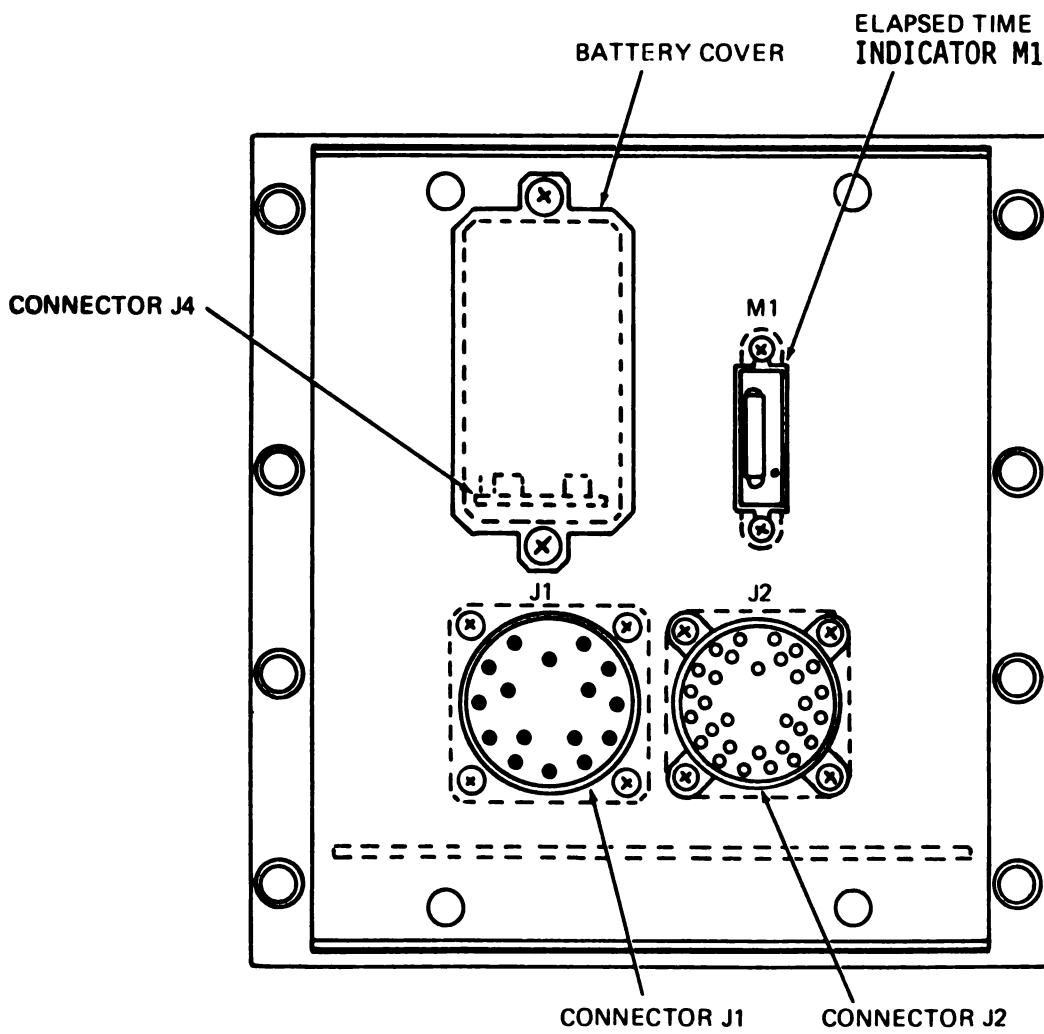
Figure 1-2. Typical aircraft installation.

a. *Description of Radar Receiver-Transmitter-Antenna RT-1193/ASN-128.* Radar Receiver-Transmitter-Antenna RT-1193/ASN-128 (receiver-transmitter-antenna) (fig. 1-1) is a separately housed component installed in the aircraft and designated unit 2. It consists of a combined antenna/radome and a receiver-transmitter housing. The combination antenna/radome utilizes a printed-grid antenna that is photo-etched on the inside surface of the radome. The receiver-transmitter electronic components are contained in a housing mounted on top of the antenna/radome. Eight mounting screws are located around the perimeter of the antenna/radome and secure the unit to a bracket mounted on the aircraft. Electrical connection to the receiver-transmitter antenna is made through a connector located on top of the receiver-transmitter-antenna housing.

b. *Description of Radar Signal Data Converter CV-3338/ASN-128.* Radar Signal Data Converter CV-3338/ASN-128 (signal data converter) (fig. 1-1) is a separately housed component installed in the aircraft and designated unit 1. A power supply and heat sink with fins is located at the rear of the signal data converter. Mounting lugs at the four corners permit bolting the unit to a shelf in the aircraft. Three electrical connectors, located below the handgrip, are used to connect the signal data con-

verter to the other components of the navigation set and to the aircraft electronics.

c. *Description of Computer-Display Unit CP-1252/ASN-128.* Computer-Display Unit CP-1252/ASN-128 (computer-display unit) (fig. 1-1) is a separately housed component installed in the aircraft and designated unit 3. All operating controls, indicators, and displays of the navigation set are located on the front panel of the computer-display unit. It also contains a keyboard to permit entry of alpha and numeric characters into memory. Eight turnlock fasteners along the outer edges of the front panel secure the unit in the aircraft control panel. Two electrical connectors located at the rear of the unit (fig. 1-3) connect the computer-display unit to the signal data converter and to the aircraft electronics. Also located on the back of the computer-display unit is an elapsed time meter, which indicates the cumulative operating time of the navigation set; and a dry cell battery, which prevents the loss of data from the computer memory when the navigation set is turned off (computer-display unit MODE switch set to OFF). The battery can be removed by removing the protective battery cover and releasing from the snap-on terminal connector J4 (fig. 1-3).



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Figure 1-3. Computer-display unit, rear view.

1-9. Tabulated Data

Table 1-1 lists the items comprising an operable equipment, and paragraph 1-10 provides per-

formance data for the navigation set. Table 1-2 identifies aircraft power and signal inputs to the navigation set.

Table 1-1. Items Comprising an Operable Equipment

Item	Qty	Dimensions (1 in.)			
		Height	Depth	Width	Weight
Radar Receiver-Transmitter-Antenna RT-1193/ASN-128.	1	5.45	14.62	13.58	11.0
Radar Signal Data Converter CV-3338/ASN-128.	1	7.80	10.81	7.56	12.0
Computer-Display Unit CP-1252/ASN-128.	1	6.00	7.23	5.75	7.5

1-10. Performance Data

a. Doppler Navigation Set AN/ASN-128.

Operational altitude:

Level flight 0 to 10,000 ft.
 Extreme attitudes 0 to 10,000 ft.

Attitude limits:

Land Roll $\pm 45^\circ$.
 Pitch $\pm 30^\circ$.
 Sea (Beaufort 1) Roll $\pm 30^\circ$.
 Pitch $\pm 20^\circ$.

Ambient operating temp (sea

level) Max. 131° F (55° C).
 Min. -65° F ($\pm 54^\circ$ C).

Along vehicle (heading) axis

velocity -50 to +350 knots.

Across vehicle axis

velocity ± 100 knots max.

Vertical velocity ± 5000 ft/min. max.

Linear aircraft acceleration:

Longitudinal -1g to +2g.
 Lateral -2g.
 Vertical velocity -1g to +2g.

Azimuth rate 10°/sec max.

Pitch rate 20°/sec max.

Roll rate 20°/sec max.

Input requirements:

Battery (for computer-
 display unit) 600 mA at 9.0 volts (nom).
 Dc power 28 + 2.0-5.5 volts dc.
 Ac power 0 to 5 volts ac, 400 \pm 20
 Hertz, single phase or
 0 to 5 volts dc

Synchro reference 26 \pm 1.3 volts ac, 400 \pm 20
 Hertz

Signal:

Roll 3-wire synchro, 26/11.8 volts,
 400 Hertz.

Pitch 3-wire synchro, 26/11.8 volts,
 400 Hertz.

Magnetic heading 3-wire synchro, 26/11.8 volts,
 400 Hertz.

True airspeed (optional) 3-wire synchrotel, 400 Hertz;
 26-volt ac excitation; 3.9
 volt line-to-line output.

b. Radar Receiver-Transmitter-Antenna RT-1193/ASN-128

Type of transmission fm-cw.

Frequency 13.325 GHz.

RF power out 50 milliwatts.

RF power source Gunn diode oscillator
 mounted in tune microwave
 cavity.
 Modulating frequency 30 kHz sine wave.
 Antenna radiator Printed grid planar array.
 Antenna pattern 4 non-coplanar beams switch at
 7.5 Hz rate.

c. Radar Signal Data Converter CV-S3338/ASN-128.

Input signals Roll, pitch magnetic heading,
 and true airspeed in 3-wire
 synchro form.

Output signals 24-bit serial digital data
 words to the computer-dis-
 play unit.

d. Computer-Display Unit CP-1252/ASN-128.

Read only memory (ROM) 8192 word storage.

Random access memory (RAM) 512 word storage.

Input signals Beam velocities, antenna cal-
 ibration constants, pitch,
 roll, magnetic heading, and
 true airspeed.

Output signals Output signals available for
 use by external equipment
 in binary-coded-decimal
 (BCD) or binary format.

Binary-coded-decimal
 (BCD) Distance to go.
 Crosstrack deviation.
 Desired track.
 Track angle error.
 Ground speed.
 Position (UTM) Northing.
 Position (UTM) Easting.
 Drift velocity.
 Vertical velocity.
 100 km square area identifier.
 (alphabetical letters).
 Built-in Test (BITE) word.
 Heading velocity.
 Binary True heading—Sine.
 —Cosine.

Roll—Sine.
 —Cosine.
 Pitch—Sine.
 —Cosine.
 Heading velocity.
 Drift velocity.

Vertical velocity.
 Bearing to destination.
 Velocity along longitudinal axis.
 Velocity along lateral axis.
 Velocity along yaw axis.
 Course deviation.
 Bearing to destination from aircraft heading.
 BITE word.

Battery Type: Battery BA-1090/U
 (Mercury cells with Snap-on terminals).
 NSN: 6135-00-836-1023.
 Voltage: 9.0 volts.
 Capacity: 575 mah.
 Length: 1.031 in.
 Width: 0.655 in.
 Height: 1.609 in.
 Shelf life: 36 months (at 35° F or below).

Table 1-2. Aircraft Power and Signal Inputs to Navigation Set

Navigation set unit	Input	Connector pin NMO.
Signal Data Converter	Heading synchro input (Y)	1J1-A
	Heading synchro input (Z)	1J1-B
	Heading synchro input (X)	1J1-C
	Roll synchro input (Y)	1J1-D
	Roll synchro input (Z)	1J1-E
	Roll synchro input (X)	1J1-F
	Pitch synchro input (Y)	1J1-G
	Pitch synchro input (Z)	1J1-H
	Pitch synchro input (X)	1J1-J
	TAS synchro input (Y)	1J1-X
	TAS synchro input (Z)	1J1-Y
	TAS synchro input (X)	1J1-S
	26 vac 400-Hz reference (high)	1J1-T
	26 vac 400-Hz reference (low)	1J1-U
Signal Data Converter-continued	+28 vdc power	1J1-W
	28 vdc power return	1J1-Z
	Chassis ground	1J1-P
Computer-Display Unit	+28 vdc power	3J1-C
	28 vdc power return	3J1-D
	0-5 vac or 0-5 vdc panel Lighting (high)	3J1-K
	0-5 vac or 0-5 vdc panel Lighting (low)	3J1-M
	28 vdc annunciator excitation	3J1-J
	Chassis ground	3J2-19
Receiver-Transmitter-Antenna	None	

Section III. FUNCTIONAL DESCRIPTION

1-11. Principles of Operation

The navigation set measures aircraft velocity by computing the Doppler frequency shifts in four radar beams transmitted toward and received back from the ground. The navigation set also receives aircraft heading, roll and pitch as synchro inputs. After conversion to digital format, the pitch and roll information is used with the Doppler frequency shifts to produce three orthogonal components of aircraft velocity. The navigation set computer uses aircraft velocity and heading information of perform navigation from an initial fix point. If a true air-speed (TAS) input is available in the aircraft, the navigation set also computes windspeed and direction.

1-12. System Operation

The navigation set is energized when the computer-

display unit MODE switch is rotated from the OFF position to any of the other positions. This causes an on/off control discrete signal to be sent from the computer-display unit to the signal data converter (fig. 1-4). The signal data converter then supplies ±15 and +5 volts dc power to the other navigation set units (RTA and CDU). It also supplies a beam switching signal and a 30-kHz frequency modulating signal to the receiver-transmitter-antenna. The receiver-transmitter-antenna generates a transmitter carrier frequency at 13.325 GHz and frequency modulates this RF carrier with the 30-kHz sinusoidal signal. The resulting frequency modulated, continuous wave (FM-CW) signal is applied to the antenna. The antenna simultaneously radiates and receives four non-coplanar switched beam signals in a sequential fashion as shown in figure 1-5. Within five seconds

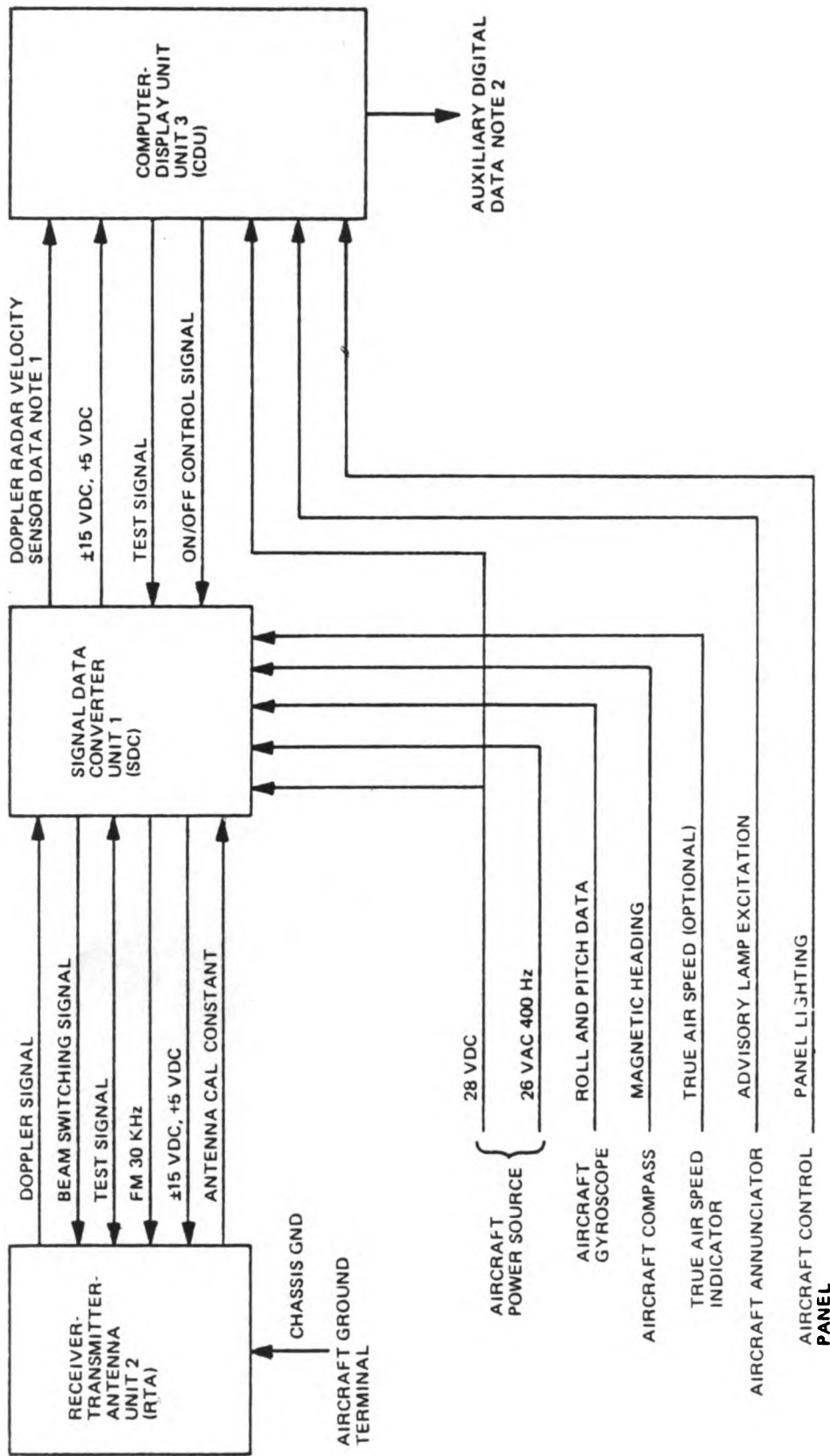
after turn-on, the Doppler radar will have searched for and locked on to the received Doppler shifted signal. The Doppler radar velocity sensor, comprised of the signal data converter and the receiver-transmitter-antenna, processes the beam velocity signals and transmits the Doppler information to the computer-display unit together with pitch, roll and magnetic heading data; antenna calibration constants; and true airspeed (optional). The computer-display unit accepts these inputs and computes the three orthogonal components of aircraft

velocity in ground coordinates, and combines aircraft velocity and magnetic heading data to compute changes in aircraft position.

During system operation the navigation set is monitored by test signals to detect failures. The computer-display unit, using its own computer as built-in-test equipment (BITE), processes these test signals and displays coded data which indicates the defective unit or circuit card of the navigation set.

1-13. Receiver-Transmitter-Antenna Operation

Next printed page is 1-10

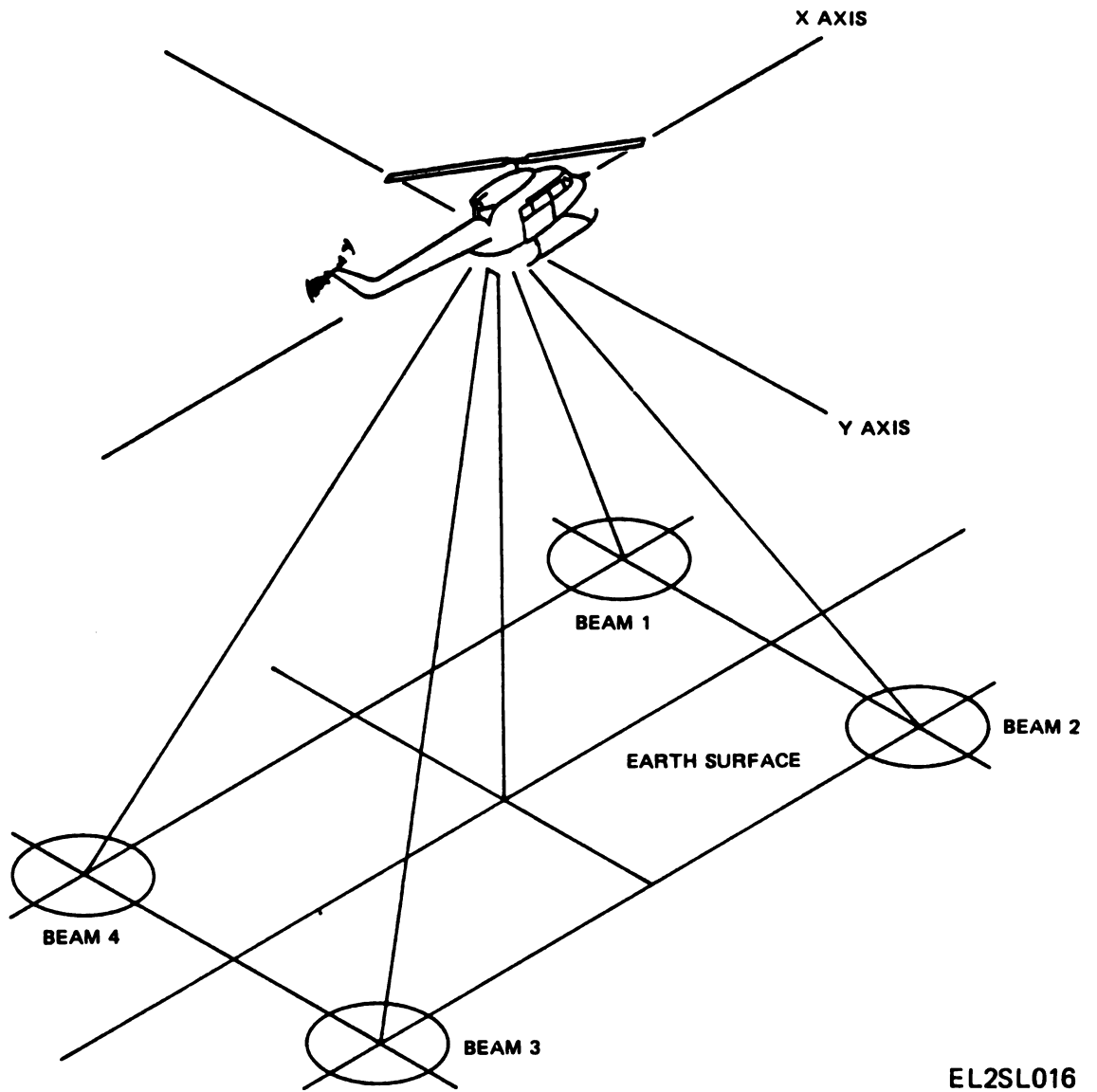


NOTES

1. DOPPLER RADAR VELOCITY SENSOR DATA CONSIST OF BEAM VELOCITIES, MAGNETIC HEADING, PITCH, ROLL, ANTENNA CALIBRATION CONSTANTS, STATUS, AND TRUE AIR SPEED (OPTIONAL) SIGNALS.
2. AUXILIARY DIGITAL DATA CONSIST OF GROUND SPEED, BEARING-TO-DESTINATION, DISTANCE-TO-GO, TRACK ANGLE AND CROSS TRACK DEVIATION, DESIRED TRACK, HEADING, VERTICAL AND DRIFT VELOCITY, AIRFRAME COORDINATE VELOCITIES (Vx, Vy, Vz), NORTHING AND EASTING, SINES AND COSINES OF TRUE HEADING, PITCH AND ROLL.

FL2SL015

Figure 1-4. Navigation Set System Block Diagram.



EL2SL016

Figure 1-5. Antenna Beam Arrangement.

a. Reference signal generator 2A2 is the source of microwave energy. It contains two active components, a Gunn diode and a varactor diode mounted in a tuned microwave cavity. The Gunn diode oscillates at a nominal frequency of 13.325 GHz, and the varactor diode is energized by a 30-kHz sinusoidal modulating signal. The resultant frequency modulated, continuous wave (FM-CW) signal is supplied to receiver-transmitter module 2A1, a microwave integrated circuit (MIC). Most of the rf energy is directed to waveguide switch 2A3 and then to antenna radiating grid 2A5. A small portion of the rf input is picked off in receiver-transmitter module 2A1, processed, and applied to balanced mixers as a local oscillator signal. Simultaneous with the rf transmission, reflected rf energy is received by antenna 2A5, and routed through waveguide switch 2A3 to the balanced mixers in the receiver-transmitter module where it is mixed with the local oscillator signal. The resultant Doppler shifted signal with sidebands at 30-KHz separations is inputted to the pre-IF circuit in electronics module 2A4.

b. Electronic module 2A4 contains the pre-IF amplifier, fm driver, and beam driver. The output of receiver-transmitter module 2A1 is amplified and buffered in the pre-IF circuits of the electronics module, and then transmitted to leakage elimination filter 1A3 in the signal data converter.

c. The fm driver signal for reference signal generator 2A2 Gunn diode oscillator is derived from a 30-kHz square wave, through a differential line receiver, from the signal data converter timer/interface 1A2. The fm drive circuit then supplies the required sinusoidal drive to the Gunn oscillator.

d. The beam driver circuits receive timing signals through differential line receivers from the signal data converter timer/interface 1A2. These signals are decoded into four beam switching signals which are used to drive, sequentially, the four beam switching diodes in waveguide switch 2A3. In the test mode, a discrete signal from timer/interface 1A2 results in the beam driver biasing off the four diodes in the waveguide switch, thereby inhibiting the transmission of microwave energy, and receiver-transmitter module 2A1 is biased to couple an amount of rf transmitted signal into the receiver circuitry. The fm drive signal is shifted in frequency, in synchronism with beam timing signals, to create a pseudo Doppler signal.

e. Waveguide switch 2A3 consists of four single-pole, single-throw solid-state switches in one integrated assembly. The rf energy from receiver-transmitter module 2A1 is provided to the input port of the switch. The switching is accomplished by beam switching signals from the electronics module

2A4 beam driver which changes the bias voltage applied to the four diodes mounted across the output port waveguide sections. As each diode is biased on, a port is open and the rf energy is transmitted through the selected port. The ports are opened one at a time, sequentially.

f. Antenna assembly 2A5 consists of the radiating grid and the antenna calibration circuit. The output from the waveguide switch is directed to the radiating structure. The radiating structure consists of an oversize waveguide (formed by top and bottom plates), where the narrow dimension has been enlarged as compared to a standard waveguide. The top plate is a continuous conducting surface, whereas the bottom plate is a dielectric with a metal grid printed on its inside surface and is made of radome material. Microwave energy is propagated into this cavity from two slotted waveguides mounted at its edges. A beam of energy is generated by feeding one end of the waveguides which produces a travelling wavefront in the parallel plate waveguide cavity. The travelling wave couples through the radiating grid to produce a beam in each of the quadrants; four non-coplanar beams are generated by sequentially feeding the four ends of the two waveguides. The antenna calibration circuit stores the antenna calibration constants in four 8-bit words. These signals are transmitted to A/D converter 1A1 in the signal data converter, in synchronism with the beam switching, and then supplied to the computer-display unit.

1-14. Signal Data Converter Operation (fig. FO-1)

a. The Doppler shifted signals with sidebands at harmonics of 30 kHz are supplied to leakage elimination filter 1A3 in the signal data converter. Leakage elimination filter 1A3 contains a 23- to 37-kHz bandpass filter which selects the 30-kHz sideband of the Doppler signals spectrum and rejects all other sideband frequencies. The resultant 30-kHz sideband frequency for each beam signal is then processed through filters to eliminate undesired zero-speed leakage. The output of leakage elimination filter 1A3 is supplied to frequency tracker 1A4.

b. Frequency tracker 1A4 consists of a single sine/cosine tracking loop which is time-shared among the four beams. When a Doppler-shifted signal is present, the tracker automatically acquires the signal within five seconds, and tracks the center frequency of the Doppler spectrum. Outputs from the tracker are time-sequence pulse trains whose frequencies are proportional to the Doppler shifts in each of the beams. The time-multiplexed pulse

trains are transmitted to timer/interface circuit card 1A2 for digitizing and transmitting to the computer-display unit.

c. A/D converter 1A1 accepts 3-wire synchro information of roll, pitch, magnetic heading and true airspeed. The inputs are first buffered and converted from 3-wire synchro data to a 4-wire sine/cosine format, using a Scott-T transformer. These signals are then fed to a multiplexer which selects the analog channel to be converted, conditions the signal, and applies the result to an A/D encoder. Antenna calibration constants are also applied to the encoder. The digitized outputs are transmitted to timer/interface circuit card 1A2.

d. Timer/interface circuit card 1A2 accepts beam velocity pulse trains from the frequency tracker and the A/D converter 1A1 outputs (roll, pitch, magnetic heading, true airspeed, antenna calibration constants), and converts them into the required serial digital format for transmission to the computer-display unit. Timer/interface 1A2 also contains an oscillator and the frequency countdown chains required to generate the basic timing signals. The signal data converter also contains power supply circuit card 1A5, which converts +28 volts dc prime power into the three regulated voltages required by the system: ± 15 volts dc and +5 volts dc.

1-15. Computer-Display Unit Operation (fig. FO-1)

a. The computer-display unit is a control, a display, and a general purpose digital computer for aircraft navigation and guidance. The computer-display unit has a capacity of 8,192 words of permanent program read-only-memory (ROM). The random-access-memory (RAM) has a capacity for 512 words. The RAM is kept energized, by a 9.0 volt dc battery (not shown) in the CDU, to keep its contents valid during temporary power interruptions in flight, and also when all power is removed so it is not necessary to re-enter all navigation data before every flight. The battery, type BA-1090/U, is accessible from the rear of the computer-display unit. Destinations and other data can be modified whenever required, but data that are unchanged need not be re-entered.

b. The front panel of the computer-display unit provides for the display of navigation data and provides the controls for mode selection, and inserting, changing and recalling of position, aircraft steering, and all other navigational data. The alpha-numeric display consists of segmented incandescent lamps. Two rotary switches are provided on the computer-display unit to separate mode and display functions. Two thumbwheels for selecting

destinations are provided, one for entering and reading out destination data, and the other for selecting the fly-to-destination; this assures that left-right steering data is always computed and the fly-to-destination number is always displayed, even when destination data are being entered or read out. A keyboard is provided for the entry of data into memory. This data may be alpha and/or numeric.

c. The RAM/ROM and CPU (Central Processing Unit) circuit cards (3A4 and 3A5, respectively) perform the major navigation computations and comprise the computer portion of the computer-display unit. Display and control of the navigation data are performed by the frame and wiring assembly and numeric displays 3A1, display logic/panel control 3A2, and input/output transmitter-receiver 3A3 circuit cards. The following paragraphs provide a description of the major computations and display of navigation data in the computer-display unit.

d. The computer-display unit keyboard and MODE switch, part of the frame and wiring assembly, allow the operator to enter wind speed and direction, destination data and initial position in either Universal Transverse Mercator (UTM) or latitude and longitude format. UTM or latitude and longitude format is selected by the UTM or LAT/LONG position, respectively, of the MODE switch. If UTM data are to be entered, or displayed, the UTM spheroid of operation is also entered by setting the DISPLAY switch to SPH/VAR and entering spheroid codes for the operational area.

e. When UTM coordinates are used, the initial position coordinates are first converted to latitude and longitude coordinates, since all computations are performed in geographical coordinates. These coordinates are then computed with the north-south (V_N) and east-west (V_E) components of velocity vectors to determine present position. After the present position latitude and longitude coordinates are computed, the coordinates are converted back to UTM coordinates and transmitted to input/output transmitter-receiver circuit card 3A3 for processing prior to display.

f. When latitude and longitude coordinates are used, the initial position coordinates are directly computed with north-south (V_N) and east-west (V_E) components of velocity vectors to determine present position. Present position latitude and longitude coordinates are then transmitted to input/output transmitter-receiver circuit card 3A3 for processing prior to display.

g. The computer-display unit input/output transmitter-receiver 3A3 receives the following signals from the signal data converter, in digital serial format, beam velocities, magnetic heading, pitch, roll, antenna calibration constants and true airspeed (op-

tional) signals. The four beam velocities, along with antenna calibration modified constants, are converted from modified ARINC-575 digital serial format to 0 to ± 5 volts dc non-return to zero (NRZ) logic data in the beam velocity logic. The four beam velocities are used to compute the aircraft velocity vector in airframe coordinates, with corrections made for antenna calibration constants.

h. Since present position computations are always performed in geographical coordinates, aircraft velocity in aircraft coordinates must be transformed into north and east coordinates. To accomplish this, pitch, roll, and magnetic heading are obtained from the aircraft vertical gyro and heading reference via the signal data converter. True heading is determined by adding magnetic variation to magnetic heading. Using these inputs, aircraft velocity in aircraft coordinates are converted into the three orthogonal components of aircraft velocity in geographical coordinates (V_N , V_E , V_V). Changes in latitude and longitude are obtained by integrating the aircraft velocities, properly scaled for earth's radius. The position changes are then added to initial present position to obtain the actual present position. If present position is to be read out in UTM coordinates, it is obtained by converting from the computed latitude and longitude.

i. To compute variation, magnetic variation is entered into the computer-display unit via the keyboard, not only for initial position but also for each destination. Present position is also inputted and variation is continuously computed as a function of present position. Variation data is then added to magnetic heading to compute true heading.

j. Steering data is computed with respect to the destination selected by the operator by means of the FLY-TO DEST thumbwheel on the computer-display unit. The computer-display unit establishes the course from initial position to the selected destination. Using this course and present position, the steering computation circuits calculate the crosstrack distance error (XTK) and the track angle error (TKE). These circuits also compute the distance, bearing, and time to the selected destination.

k. Another computation performed by the computer, when the true airspeed (TAS) is available, is wind speed and direction. Since wind data is computed in north and east coordinates, the true airspeed input (TAS) must be converted into horizontal coordinates (TAS_N and TAS_E). This calculation, the computer-display unit uses these TAS coordinates and the Doppler radar velocity sensor derived velocity (V_N and V_E). The vector difference between these quantities is the wind velocity vector. The wind data (W_N , W_E) is filtered and available for

display; it is also stored in memory (remembered). If a malfunction occurs and Doppler velocity is invalid, or the backup mode is selected manually, TAS and stored wind data from previous computations are used to calculate the ground speed vector (V_N , V_E). In the backup mode, the wind vector can be updated by entering enroute wind data through use of the keyboard with the DISPLAY switch set to WIND SP/DIR.

l. Navigation data transmitted from RAM/ROM and CPU circuit card 3A4 and 3A5, respectively, to input/output transmitter-receiver circuit card 3A3 consist of present position, aircraft attitude and velocity, and steering information. Input/output transmitter-receiver 3A3 accumulates and distributes these signals to numeric displays 3A1 and display logic/panel control 3A2 circuit cards. Numeric displays 3A1 receives numeric data coded in binary-coded-decimal (BCD) format, and converts the BCD to seven segment code to drive the numeric digital display characters. Sixteen segment code is transferred from input/output transmitter-receiver 3A3 to display logic/panel control 3A2 and is used to drive the alpha digital display characters. Display logic/panel control 3A2 also receives keyboard and switch control inputs from the front panel controls. These data inputs are transmitted to CPU 3A5 for entry and computation.

m. The computer-display unit also contains post regulator and control circuit card 3A6 which provides lamp driver power and failure protection circuits.

1-16. Self-Test Capability (fig. FO-1)

a. The navigation set includes a self-test capability. The computer-display unit is checked on a continuous basis by use of built-in-test-equipment (BITE) and the Doppler radar velocity sensor is tested by setting the computer-display unit MODE switch to TEST. Power supply 1A5 in the signal data converter is also monitored on a continuous basis by use of BITE.

b. The computer program incorporates tests to verify that the computer is functioning correctly. It also outputs to input/output transmitter receiver 3A3 a test word which is fed back to central processing unit 3A5, where it is validated. When the navigation set is operating satisfactorily, CPU 3A5 periodically transmits a BITE timer reset pulse to input/output transmitter receiver 3A3. If a failure occurs, the BITE timer is not reset and causes the MAL indicator light, located in the MAL indicator light, located in the frame and wiring assembly, to light. CPU 3A5 also transmits a failure code to in-

put/output transmitter receiver 3A3, which is displayed when the MODE switch is set to TEST.

c. When the computer-display unit MODE switch is set to TEST, the Doppler radar velocity sensor transmits test velocities, test angle, and test calibration constant signals to the computer-display unit. The computer-display unit compares these signals to stored constants to determine the operating status of the Doppler radar velocity sensor. If a failure occurs, CPU 3A5 transmits a failure code to input/output transmitter receiver 3A3 and fails to transmit the BITE timer reset pulse, which

causes the MAL indicator lamp to light.

d. Failure in signal data converter power supply 1A5 results in transmission of a failure discrete signal to input/output transmitter receiver 3A3, where it is used to light both the MEM and MAL indicator lamps in the frame and wiring assembly.

1-17. Interconnecting Diagram

Navigation Set Interconnecting Diagram, figure FO-2, shows signal flow to and from the three navigation set units.

CHAPTER 2 SERVICE UPON RECEIPT AND INSTALLATION

Section 1. SERVICE UPON RECEIPT OF MATERIAL

2-1. Unpacking and Packing (fig. 2-1)

CAUTION

The receiver-transmitter-antenna radome surface must be placed on a foam rubber pad approximately 2 feet by 2 feet and 2 inches thick or equivalent during bench tests, storage, and transportation to and from the aircraft.

The four sides of the receiver-transmitter-antenna are sealed with a resilient compound to prevent penetration by fluids. Care must be taken to prevent damage to the sealed surfaces.

Each component of the navigation set (table 1-1) is packed similarly. Figure 2-1 (sheets 1, 2, and 3) show the packing details for the respective component of the navigation set. Open the outer container and remove the hair cushioning. Then, open the inner container and remove the bubble pack and the component. Retain the container and packing materials for re-use. Refer to SB 11-643 for in-

formation pertaining to the return procedures required for the reliability improvement warranty (RIW).

2-2. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6 (Packaging Improvement Report).

b. Check the equipment against the component listing in table 1-1 or the packing slip to see if the shipment is complete. Report all discrepancies in accordance with paragraph 1-3. The equipment should be placed in service even through a minor assembly or part that does not affect proper functioning is missing.

c. Check to see whether the equipment has been modified. (Equipment which has been modified will have the MWO number on the front panel, near the nomenclature plate.) Check also to see whether all currently applicable MWO's have been applied. (Current MWO's applicable to the equipment are listed in DA PAM 310-4.

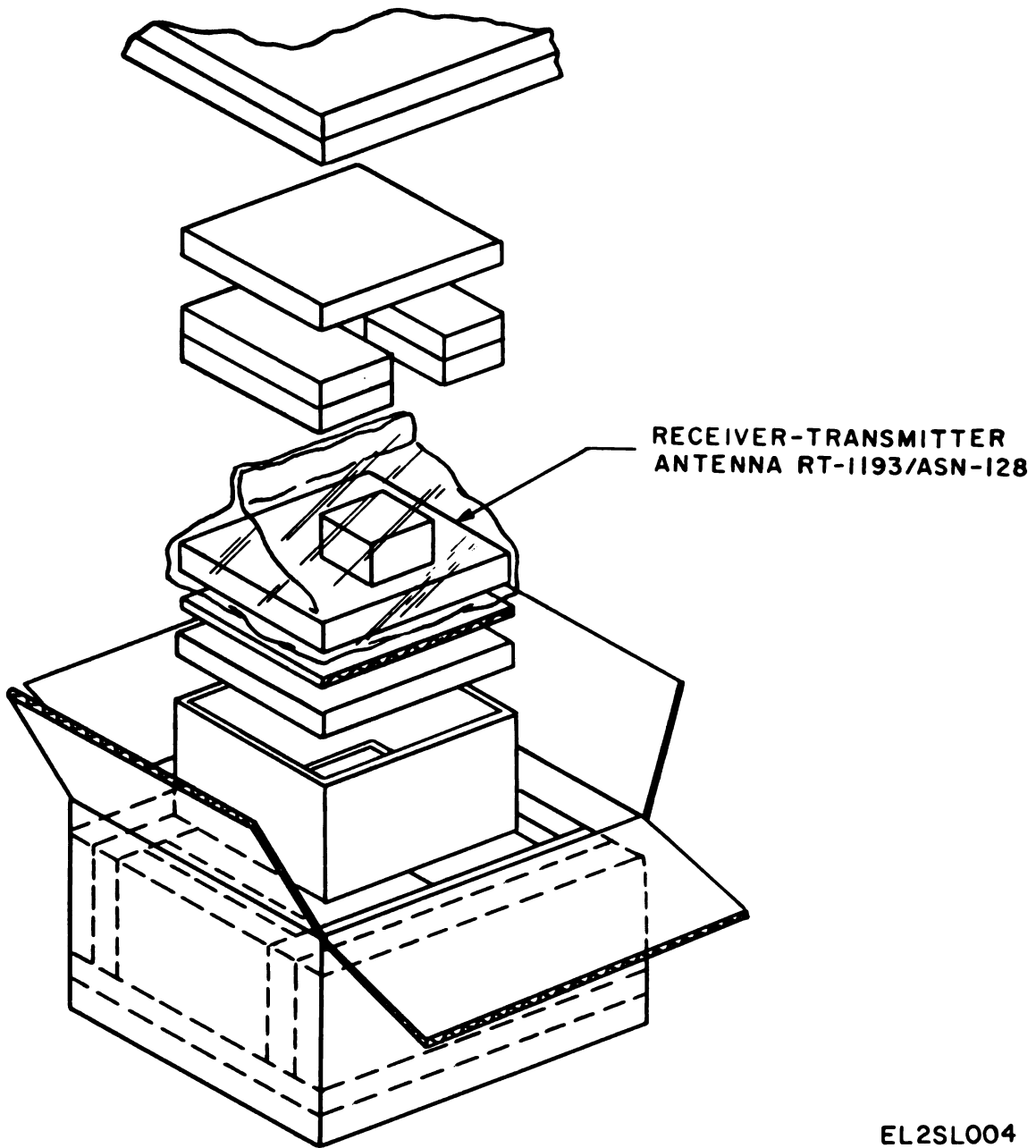
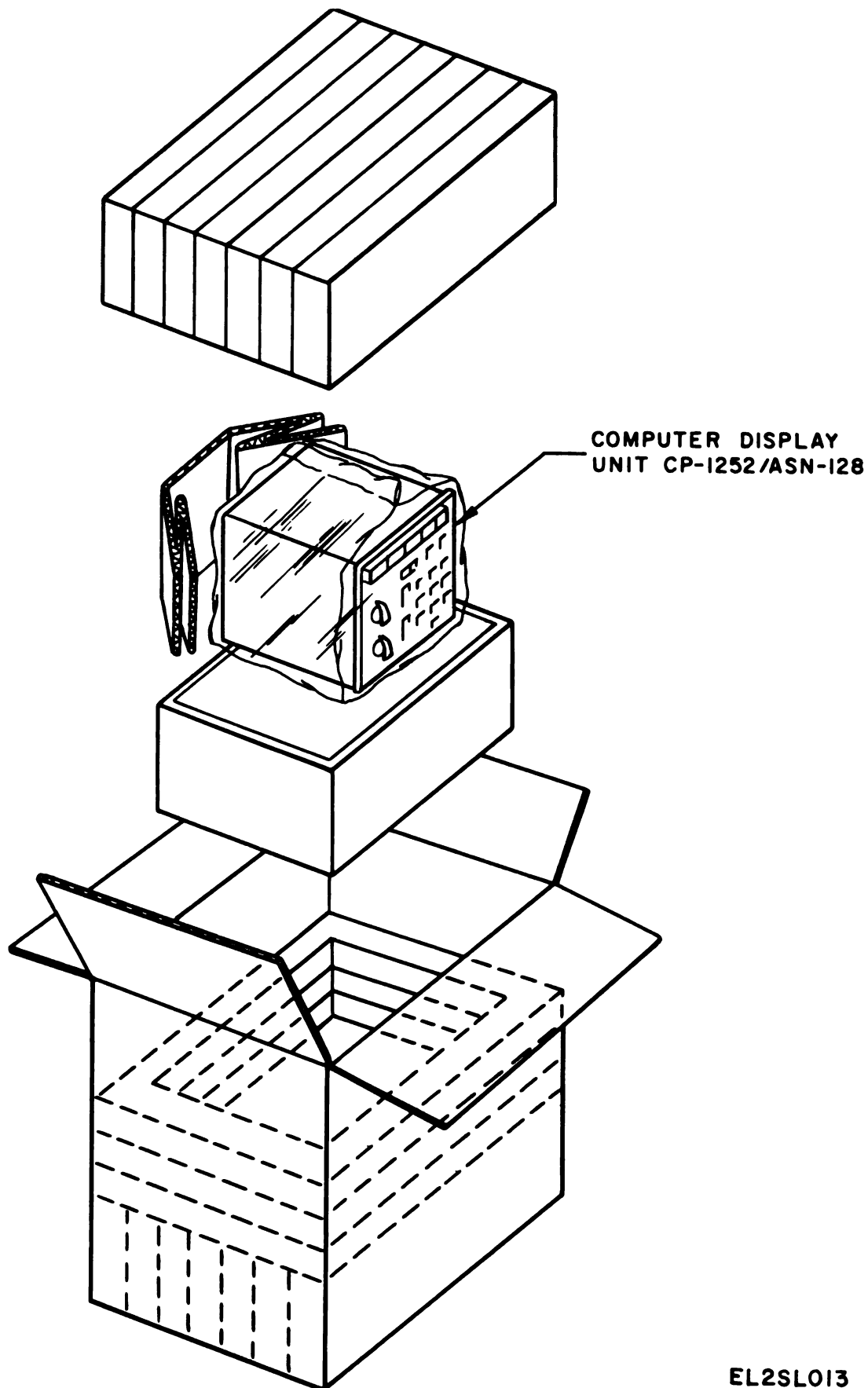
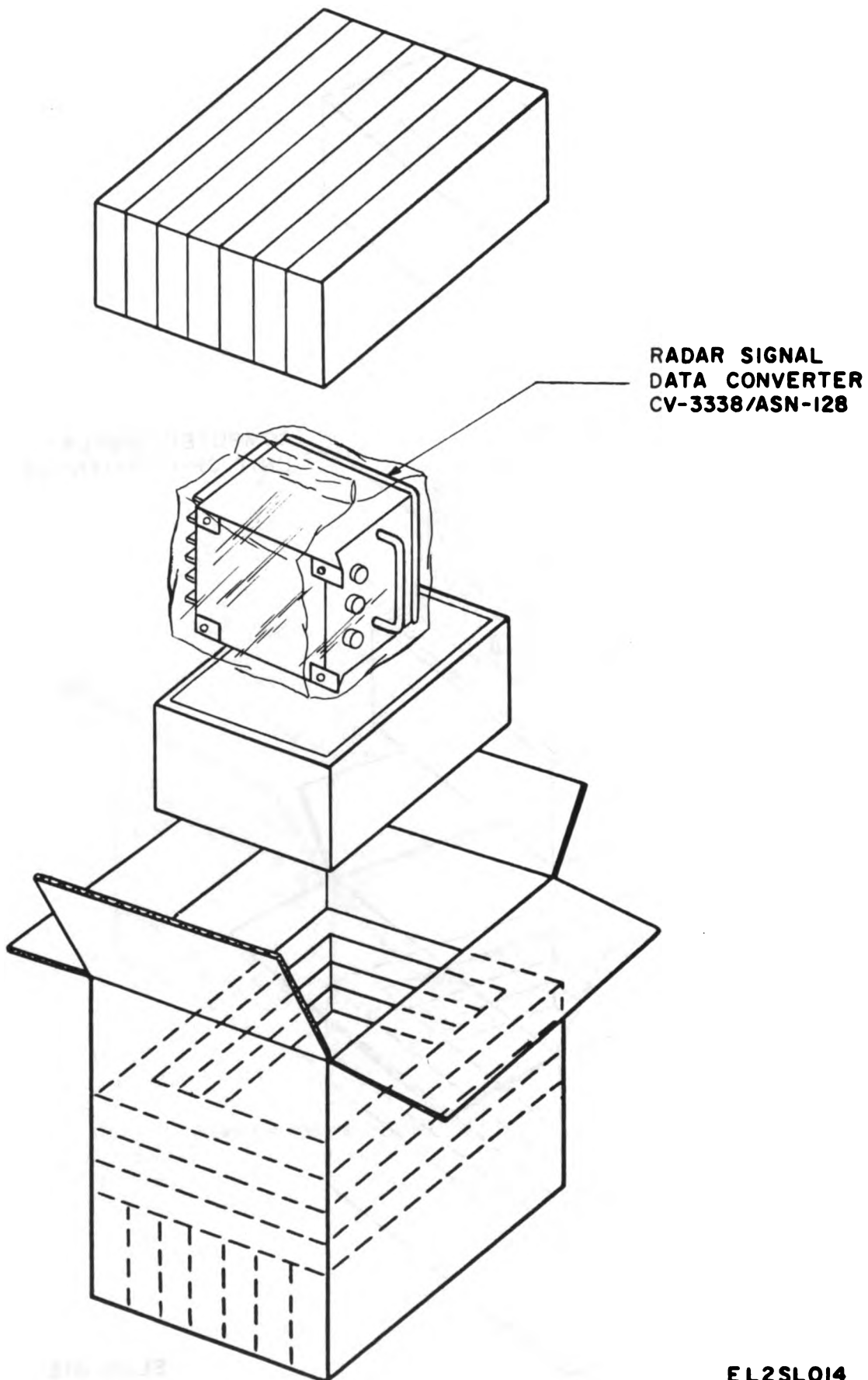


Figure 2-1. Packing and unpacking of navigation set units (sheet 1 of 3).



EL2SL013

Figure 2-1. Packing and unpacking of navigation set units (sheet 2 of 3).



EL2SL014

d. For dimensions, weights, and volume of packaged items, refer to SB 700-20.

2-3. Packaging

NOTE

Doppler Navigation Set AN/ASN-128 is maintained under a *Reliability Improvement Warranty* (RIW) provided by the manufacturer. Follow directions on the warranty notice plate attached to

each item. The Government will verify failures before the return of the item. Provide failure date and failure data, and use appropriate packing and packaging when returning units under the RIW. Do not break or tamper with seals, or the RIW may be invalid for that item.

Package the faulty navigation set component for return to manufacturer in accordance with figure 2-1 (sheets 1, 2, and 3).

Section II. INSTALLATION INSTRUCTIONS

2-4. Tools and Materials

The equivalent tools used and materials expended during installation of the navigation set are listed in table 2-1.

Table 2-1. Tools and Material Used for Installation

Items	Purpose
Tool Kit, Electronic Equipment TK-101/G (NSN 5180-00-064-5178).	Installation and removal of navigation set
No. 10 bolt (4 ea).	Installation of signal data converter.
No. 10 lockwasher (4 ea).	Installation of signal data converter.
No. 10 flatwasher (4 ea).	Installation of signal data converter.
No. 10 nut (4 ea).	Installation of signal data converter.
No. 6-32 × 1-inch. Screw (8 ea) ^a .	Installation of receiver-transmitter-antenna.
No. 6 flatwasher.	Installation of receiver-transmitter-antenna.
No. 6 lockwasher.	Installation of receiver-transmitter-antenna.
Braided Ground strap (1 ea).	To connect electrical bonding surface at top of receiver-transmitter-antenna housing to airframe ground stud.
No. 6-32 × 3/8-inch screw (1 ea).	To connect braided ground strap to top of receiver-transmitter-antenna housing.
Foam rubber pad (1 piece, 2 ft by 2 ft 2 inches thick).	To provide protective surface for receiver-transmitter-antenna redome when removed from aircraft mounting area.

^aLength of screw may vary, depending on depth of airframe threaded-mounted hole.

2-5. Installation

a. General.

(1) The installation of Doppler Navigation Set AN/ASN-128 will have been accomplished by an airframe manufacturer or an Army maintenance facility. Removal and replacement procedures of the AN/ASN-128 units are given in chapter 5. Table 2-1 lists the tools and materials used for installation.

(2) Before installing the computer-display unit in the aircraft, install the Battery BA-1090/U. At the rear of the computer-display unit, remove the two Phillips screws and the battery cover (fig. 1-3). Insert the battery into the snap-on terminals of connector J4. Replace the battery cover and secure the two screws.

(3) For complete interunit wiring of the AN/ASN-128 in specific aircraft, refer to the applicable aircraft electronic equipment configuration manual.

CAUTION

Be extremely careful to prevent entrance of non-contained fuel, oil, or other foreign substances into the compartment in which the equipment is installed.

b. Computer-Display Unit CP-1252/ASN-128.

NOTE

Check to see that the Computer-Display Unit battery is properly installed in the Computer-Display Unit (a (2) above).

(1) Set front panel MODE switch to OFF (fig. 3-1). The MODE switch knob must be pulled forward to replace in the OFF position.

(2) Locate the mounting area on the aircraft control panel.

(3) Record date of installation on the installation log plate (fig. 2-2) attached to the item. The time totalizing meter reading will have been recorded by the manufacturer. Data shall be recor-

ded using black epoxy ink with a straight nib pen (or an equivalent). Allow to air dry at 65°F (18°C) minimum until the ink is tack free before handling (approximately 30 minutes). No protective spray is required.

(4) Connect aircraft branched cable connector W3P1 (fig. 2-3) to connector 3J1 on back of the unit.

(5) Connect aircraft branched cable connector W3P2 to connector 3J2 on back of the unit.

(6) Carefully insert the unit into the control panel.

(7) Secure in place with the eight turnlock fasteners on the sides of the unit.

c. Radar Signal Data Converter CV-3338/ASN-128.

(1) Locate the mounting plate in the equipment bay on which the unit is to be mounted.

(2) Record date of installation on the installation log plate (fig. 2-2) attached to the unit. Data shall be recorded using black epoxy ink with a straight nib pen (or an equivalent). Allow to air dry at 65°F (18°C) minimum until the ink is tack free before handling (approximately 30 minutes). No protective spray is required.

(3) Secure in position with four No. 10 bolts, lockwashers, flatwashers, and nuts through the mounting lugs at the corners of the unit.

NOTE

The four nuts are NOT required if the mounting holes are tapped.

(4) Connect aircraft branched cable connector W1P1 (fig. 2-3) to connector 1J1.

(5) Connect aircraft branched cable connector W3P3 to connector 1J3.

(6) Connect aircraft cable connector W2P2 to connector 1J2.

d. Radar Receiver-Transmitter-Antenna RT-1193/ASN-128. The manner in which the receiver-transmitter-antenna is installed depends on the aircraft. It may be mounted flush with the bottom of the aircraft fuselage, or it may be mounted underneath the fuselage. To facilitate the various installation methods, the eight mounting holes (fig. 2-4) will accept screws from either the top or bottom surface. When the top surface is used as a mounting surface, sealing compound and rubber plug must be removed from each mounting hole prior to installation.

Whatever form of bracket is used, the bracket contains mounting slots which mate with alignment pins. There are four alignment pins, two on the top surface and two on the bottom surface of the unit, which protrude 0.08 inch above the surface. Refer to the Aircraft Electronics Configuration Organizational Maintenance Manual for a description of the mounting bracket.

(1) Record date of installation on the in-

stallation log plate (fig. 2-2) attached to the unit. Data shall be recorded using black epoxy ink with a straight nib pen (or an equivalent). Allow to air dry at 65°F (18°C) minimum until the ink is tack free before handling (approximately 30 minutes). No protective spray is required.

CAUTION

Four sides of the unit are sealed with a resilient compound to prevent penetration by fluids. Care must be taken to avoid damaging the sealed surfaces. Any cuts or scratches that extend through the resilient compound must be repaired before unit can be installed.

The receiver-transmitter-antenna radome surface must be placed on a foam rubber pad approximately 2 feet by 2 feet and 2 inches thick or equivalent during bench test, storage, and transfer to and from the aircraft. Be careful when installing the receiver-transmitter-antenna not to damage the alignment holes or alignment pins (fig. 2-4). The alignment holes have been precisely located in the mounting bracket. Be extremely careful to prevent entrance of non-contained fuel, oil, or other foreign substances into the compartment in which the equipment is installed, and on the external surface of the receiver-transmitter-antenna.

(2) Carefully place the unit on the mounting bracket so that the alignment pins and mounting bracket slots mate, and the *fore* line (fig. 2-4) is toward the front of the aircraft.

(3) Secure the unit to the bracket with eight 6-32 X 1-inch screws inserted through the mounting holes.

NOTE

The 1-inch screws are for a 1/8-inch thick bracket. When the bracket is thicker, the screws must be proportionally longer.

(4) Secure the braided ground strap to the mounting hole (fig. 2-4) with a 6-32 X 3/8-inch screw. Secure the other end of the ground strap to an airframe ground stud.

(5) Connect aircraft cable connector W2P1 to connector 2J1 (fig. 2-3).

2-6 Post-Installation Checkout

Perform the following post-installation checks.

a. Check to see that the installation date is recorded on the installation plate (fig. 2-2) of each item.

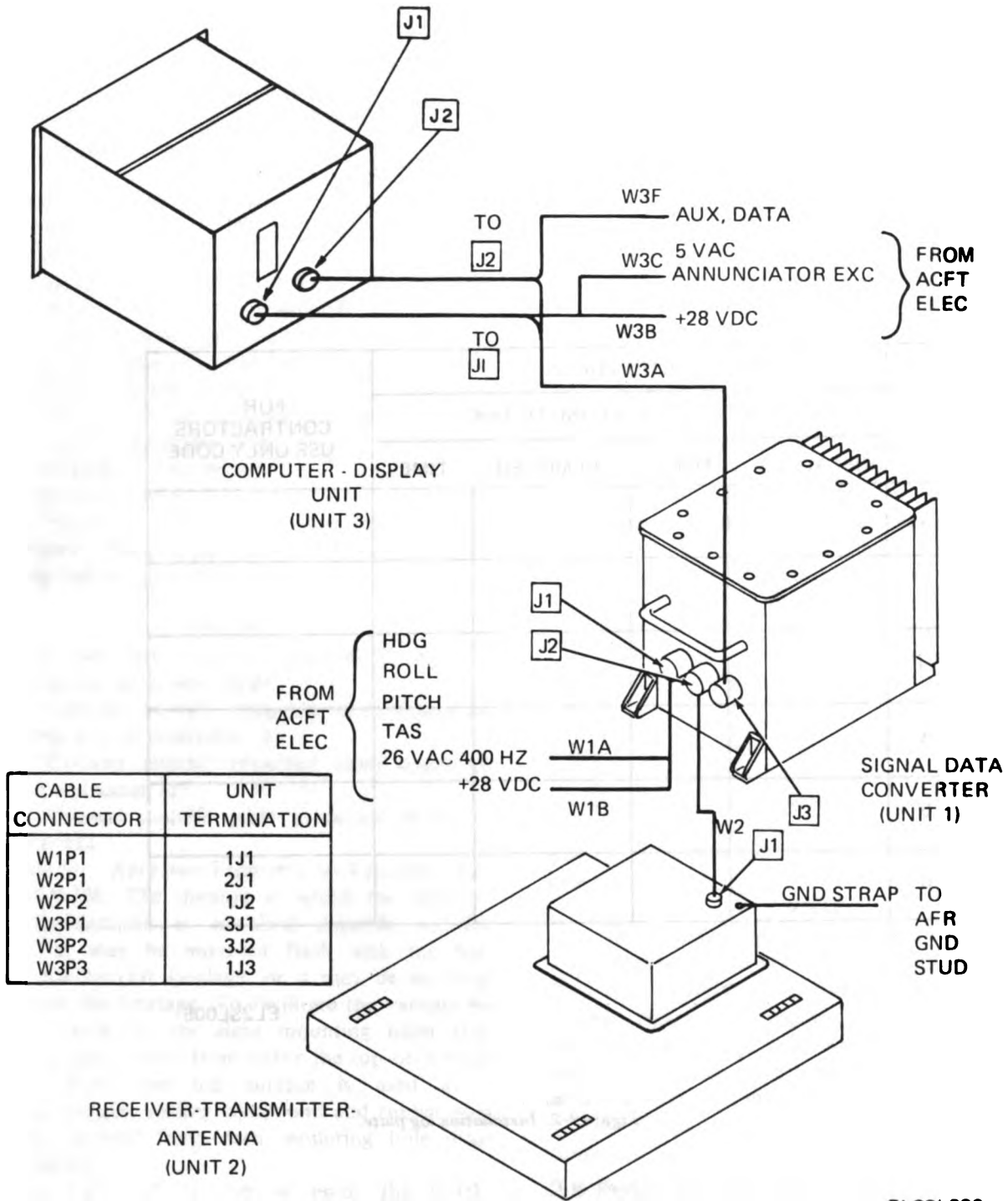
b. Check to see that each unit is secured properly to the airframe.

c. Check to see that all cable connectors are secure and connected to the proper connector (fig. 2-3).

	INSTALLATION DATA				FOR CONTRACTORS USE ONLY CODE
	DATE & TIME TOTALIZING METER				
	INSTALLED	TIME	REMOVED	TIME	
1					
2					
3					
4					
5					
6					

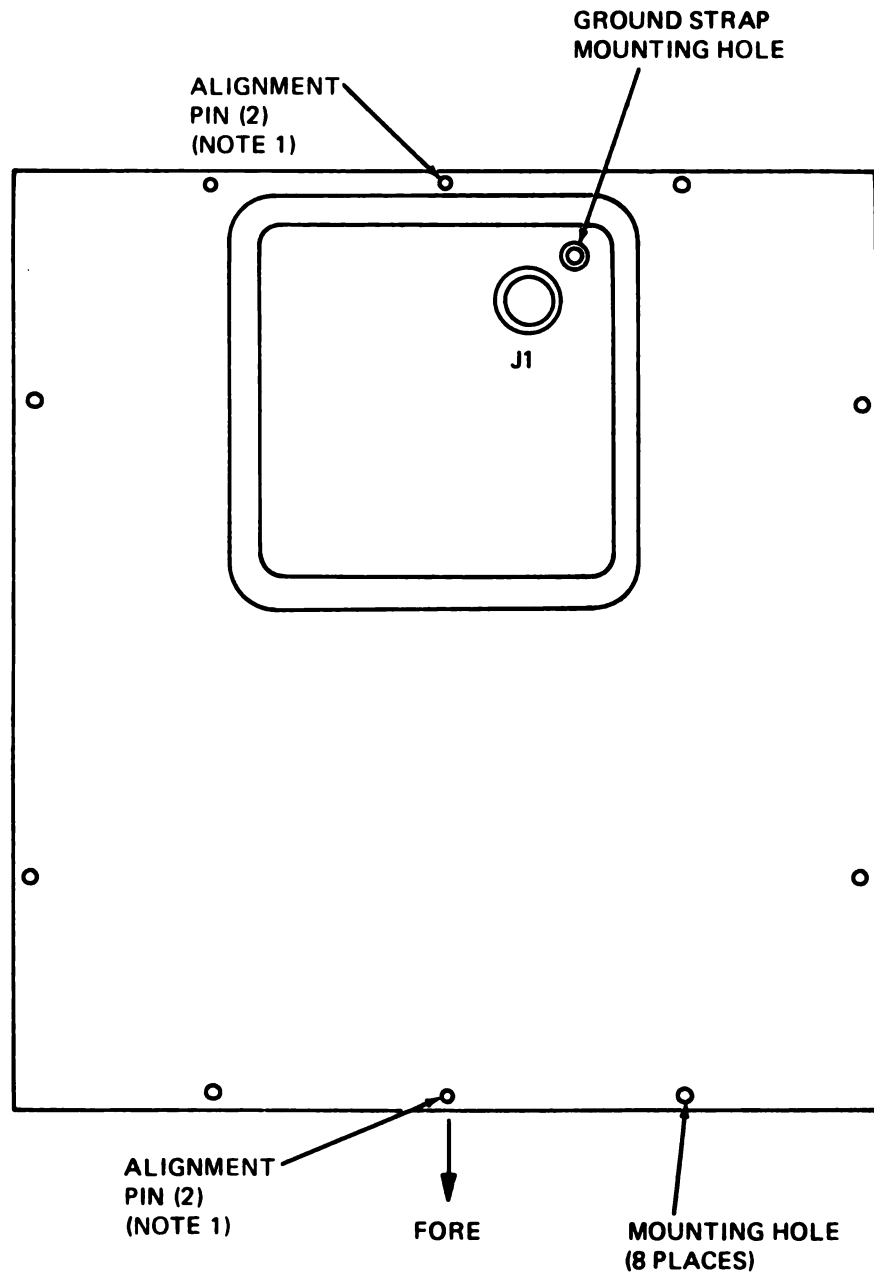
EL2SL005

Figure 2-2. Installation log plate.



EL2SL006

Figure 2-3. Doppler Navigation Set AN/ASN-128 cabling diagram.



NOTE 1: SECOND ALIGNMENT PIN PROTRUDES FROM OPPOSITE (BOTTOM) SURFACE.

EL2SL007

Figure 2-4. Receiver-transmitter-antenna Installation data, top view.

CHAPTER 3

OPERATING INSTRUCTIONS

Section I. OPERATOR'S CONTROLS AND INSTRUMENTS

3-1. Operator's Controls and Indicators
Controls and indicators for Computer-Display Unit

CP-1252/ASN-128 are shown in figure 3-1 and listed in table 3-1.

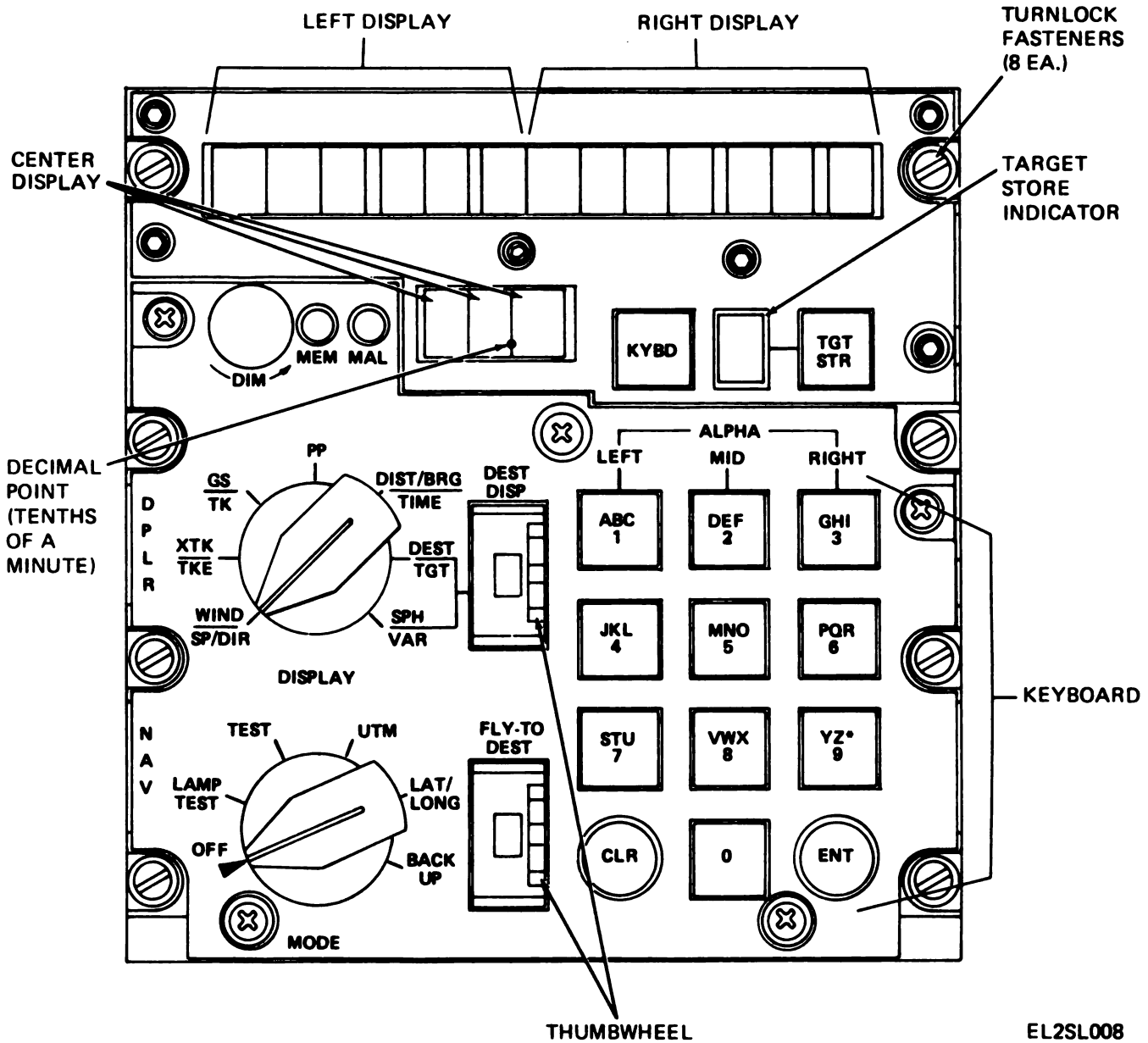


Figure 3-1. Computer-Display Unit CP-1252/ASN-128 controls and indicators.

EL2SL008

Table 3-1. Controls and Indicators

Control or indicator	Function	
MODE (6-position rotary switch).	Selects navigation set mode of operation.	
	<i>Sw pos</i>	<i>Function</i>
	NOTE	
	The MODE switch is locked in the OFF position and must be pulled out and turned to get into or out of OFF position.	
	OFF.	In this position, the navigation set is inoperable; however, an internal battery maintains random access memory (RAM) voltages to retain stored data.
	LAMP TEST.	Checks operation of all lamps.
	TEST.	Initiates built-in self-test, exercise for the navigation set.
	UTM.	Selects Universal Transverse Mercator (UTM) navigational mode of operation.
	LAT/LONG.	Selects latitude/longitude navigational mode of operation.
	BACK UP.	Places navigation set in true airspeed plus remembered wind mode of operation if true airspeed is available. If true airspeed is not available, places navigation set in remembered velocity mode of operation.
DISPLAY (7-position rotary switch).	Selects data for display.	
	<i>Sw pos</i>	<i>Function</i>
	WIND/SP/DIR (with TAS).	Left display. Wind speed (kilometers per hour (km/h)). Right display. Wind direction relative to true North (degrees).
	WIND/SP/DIR (without TAS).	Left display. An asterisk (no wind speed data available). Right display. An asterisk (no direction data available).
	XTK/TKE.	Left display. Distance crosstrack (XTK) is displayed as right or left (R or L) of initial course to destination in km and tenths of a km. Right display. Track angle error (TKE) is displayed as right or left (R or L) of bearing to destination in degrees. (The R or L designates the direction of flight to reduce the error.)
	GS/TK.	Left display. Groundspeed (GS) in km/h. Right display. Track angle (TK) in degrees relative to true north.
	PP (present position) (MODE switch set to UTM).	Center display. UTM zone. Left display. UTM area and easting. Right display. Northing
	PP (present position) (MODE switch set to LAT/LONG).	Left display. Latitude in degrees, minutes, and tenths of a minute. Right display. Longitude in degrees, minutes, and tenths of a minute.
	DIST / B R G / TIME.	Center display. Time to destination selected by FLY-TO DEST thumbwheel (in minutes and tenths of a minute). Left display. Distance to destination selected by FLY-TO DEST thumbwheel (in km and tenths of a km). Right display. Bearing to destination selected by FLY-TO DEST thumbwheel (in degrees).
	DEST/TGT (MODE switch set to UTM).	Center display. UTM zone of destination selected by DEST DISP thumbwheel. Left display. UTM area and easting of destination set on DEST DISP thumbwheel. Right display. Northing of destination set on DEST DISP thumbwheel.
	DEST/TGT (MODE switch set to LAT/LONG).	Left display. Longitude of destination set on DEST DISP thumbwheel. Right display. Latitude (N 84° or S 80° max.) of destination set on DEST DISP thumbwheel.
	SPH/VAR	Left display. Spheroid code of destination set on DEST DISP thumbwheel. Right display. Magnetic variation (in degrees and tenths of a degree) of destination set on DEST DISP thumbwheel.

Table 3-1. Controls and Indicators—Continued

Control or indicator	Function
DIM control. MEM lamp. MAL lamp.	Controls light intensity of the display characters. Lights when the radar portion of navigation set is in a non-track condition. Lights when a navigation set malfunction is detected by the built-in self-test and during operation and in the TEST mode.
Left display, right display and center display lamps. KYBD pushbutton	Lights to provide the data, in alphanumeric and numeric characters, as determined by the setting of the DISPLAY switch, the MODE switch and operation of keyboard. Use in conjunction with the keyboard to allow data to be displayed and subsequently entered into the computer when the ENT key is pressed. When the KYBD pushbutton is pressed once, the display is frozen. Additional operations of the KYBD pushbutton are necessary to enter data. Refer to paragraph 3-5a for a discussion of these operations.
Target store indicator.	Displays the destination number (memory location) in which present position will be stored when TGT STR pushbutton is pressed.
TGT STR pushbutton. Keyboard.	Stores present position data when pressed. Use to set up data for entry into memory. When DISPLAY switch is set to position in which new data is required and KYBD pushbutton is pressed, data may be displayed on the appropriate left, right, or center display. To display a number, press the corresponding key or keys (1 through 0). To display a letter, first press the key corresponding to the desired letter; then press a key in the left, mid, or right column corresponding to the position of the letter on the key. Example: To enter an L, first press L, then 3, 6, or 9 in the right column.
ENT key.	Enters data set up on keyboard and displayed on the left, right or center display into memory when pressed.
CLR key.	Clears last keyboard entered character when pressed once. When pressed twice, clears entire left, right, or center display panel under keyboard control.
FLY-TO DEST thumbwheel.	Selects the destination for which XTK/TKE (left and right displays) or DIST/BRG/TIME (left, right, and center displays) are displayed when the DISPLAY switch is set to either of these positions.
DEST DISP thumbwheel.	Used in conjunction with the DEST/TGT and SPH/BAR positions of the DISPLAY switch to select the destination whose coordinates or magnetic variation are to be displayed or are to be entered.

Section II.

OPERATION UNDER USUAL CONDITIONS

3-2. Preoperating Procedure

a. Prior to operating the navigation set, refer to the applicable aircraft configuration manual for additional requirements. The following inputs are required and supplied to the navigation set via the aircraft's AVIONIC system:

- (1) Pitch and roll from a vertical reference in synchro form.
- (2) Heading from a heading reference such as a magnetic compass in synchro form.
- (3) True airspeed, if available, in synchro form.
- (4) 28 vdc, 100 watts maximum (primary power).
- (5) 26 vac, 400 Hz (synchro reference).
- (6) Variable 5 vac, 400 Hz, 8 watts maximum (panel lighting).

b. Before adjusting any controls of the navigation set, read paragraphs 3-1, and 3-3 through 3-5.

3-3. Operating Modes

Operations of the navigation set, including selection of modes and displays, and entry and readout of data, is performed by use of the computer-display unit front panel. The navigation set has four basic modes of operation: off, navigate, test, and backup.

a. *Off Mode.* In the off mode, the system is inoperable. However, the edge lighting panel is lighted by an external aircraft power source, and a battery in the computer-display unit protects the random access memory (RAM) against loss of stored data.

b. *Navigate Mode.* In the navigate mode (UTM or LAT/LONG position of the MODE switch), power is applied to all system components, and all required outputs and functions are provided. The Signal data converter (SDC) and receiver-transmitter-antenna (RTA) measure aircraft

velocity, and convert analog heading, pitch, roll, and true airspeed into digital form; these data are then sent to the computer-display unit (CDU) for processing.

(1) Changes in present position are computed and added to initial position to determine the instantaneous latitude/longitude of the aircraft. Destination and present position coordinates can be entered and displayed in UTM and latitude/longitude; navigation is performed in latitude/longitude for computational convenience only. At the same time, distance, bearing and time-to-go to any one of 10 preset destinations are computed. A preset destination is selected by the FLY-TO DEST thumbwheel on the computer-display unit. Using the true airspeed (TAS) input, when available in the aircraft, the system computes the vector difference, between ground velocity (radar Doppler input) and air velocity (TAS sensor) to determine windspeed and direction.

(2) For a very small portion of total operating time, the navigation set may lose the radar Doppler input signal (for example, over glassy smooth water). Under this condition, the MEM light will light, and navigation computations will continue using last remembered ground speed and track angle (if no true airspeed is available), or true airspeed and remembered windspeed and direction, if true airspeed is available.

c. Test Mode. The test mode contains two functions: LAMP TEST, in which all display segments are lighted; and TEST, in which system operation is verified. In the LAMP TEST mode, system operation is identical with that of the navigate mode except that all lamp segments and the MEM and MAL indicator lamps are lighted to verify their operation. In TEST mode, the system antenna does not transmit or receive electromagnetic energy; instead, self-generated test signals are inserted into the electronics to verify operation of the navigation set. Navigation computations continue using remembered velocity or, if true airspeed is available, using true airspeed plus remembered windspeed. In the test mode, the navigation set test results are displayed on the computer-display unit front panel for approximately the first 15 seconds. At the end of this period, either GO is displayed, if there is no malfunction in the navigation set, or a failure code is displayed, if a malfunction has occurred. As long as the navigation set is maintained in the test mode, no navigation data can be displayed on the computer-display unit front panel.

(1) If a malfunction occurs, the MAL indicator lamp lights and either BU (backup) or MN (manual navigation) is displayed. If true airspeed is available BU is displayed and the failure is such that the

system can be used for navigation. If true airspeed is not available, or cannot be used because of the nature of the failure, MN is displayed, and the operator should set the MODE switch to the BACK UP position. The failed unit and the failed circuit card are also indicated by the code on the display.

(2) The computer-display unit is continuously monitored for failures by use of its own computer as self-test built-in-test-equipment (BITE). Any malfunction in the computer-display unit (CDU) or navigation set power supply causes the MAL indicator lamp on the CDU to light.

d. Backup Mode. In the backup mode, the type of operation depends upon the availability of true airspeed.

(1) When true airspeed is available, navigation set velocity data are replaced with the vector sum of true airspeed and remembered wind data previously computed by the computer-display unit. Windspeed and direction can be manually updated through use of the keyboard and the DISPLAY switch in the WIND SP/DIR position. The operator can also manually insert groundspeed and track angle with the keyboard and the DISPLAY switch in the GS/TK position.

(2) When true airspeed is not available, remembered velocity data are used for navigation. This remembered velocity data can be manually updated through use of the keyboard and the DISPLAY switch in the GS/TK position.

NOTE

When GS/TK values are inserted under these conditions, navigation continues using only these values, and true airspeed and wind data are ignored thereafter.

3-4. Computer-Display Unit Operation

a. Various required operating data, such as initial (or updated) present position, destination coordinates, and magnetic variation (para 3-5d) can be entered at any time into the computer-display unit with its keyboard. In most cases, these data will be entered before the aircraft takes off. Magnetic variation can be entered for each destination, and the system will compute present position magnetic variation. If operation is to occur in a region with a relatively constant magnetic variation, the operator enters only the magnetic variation for present position, and the computer will use this value throughout the flight. If UTM data are to be entered, or displayed, the UTM spheroid of operation is also entered.

b. To initialize present position, the MODE switch is set to UTM or LAT/LONG, the DISPLAY switch is set to DEST/TGT position, the DEST DISP thumbwheel is rotated to indicate P, and the KYBD pushbutton is pressed. The coordinates of the initial present position are entered by

use of the KYBD key and keyboard and then the ENT key is pressed when the aircraft is at the present position coordinates. The computer then determines changes from the initial position continuously, and the coordinates of the current present position can be read either by remaining in this configuration or by setting the DISPLAY switch to PP (present position) and the MODE switch to UTM or LAT/LONG.

c. To update present position over a stored destination, the KYBD pushbutton is pressed when the aircraft is over this destination. If an update is desired, the ENT key is pressed and the update is completed. The DISPLAY switch is in the DIST/BRG/TIME position during this process, and the distance-to-go displayed while over the stored destination is the present position error of the system at that moment. To update present position over a fix point not previously stored in the computer, the DISPLAY switch is placed in PP and KYBD pushbutton is pressed as the fix point is overflown. This action freezes the present position display, while allowing computation of changes in present position to continue within the computer. If an update is required, the coordinates of the fix point are entered by use of the keyboard, and then the ENT key pressed. The position change which occurred, since over-flying the fix point, is automatically added to the fix point coordinates to complete the position update.

d. Target-of-opportunity data can be entered by pressing the TGT STR (target store) pushbutton when the target is overflown. This operation stores, sequentially, the coordinates of the target in one of four destination locations in the computer: Locations 6, 7, 8, and 9. The location is displayed in the target store indicator adjacent to the TGT STR pushbutton.

e. Self-test of the navigation set is accomplished by use of built-in-test-equipment (BITE), and all units connected and energized for normal operation. Self-test enables isolating failures to either one of the three units. Self-test is accomplished as follows:

(1) The computer-display unit (except for the keyboard and left, right and center displays) is checked on a continuous basis, and any failure is displayed by the illumination of the MAL indicator lamp on the computer-display unit.

(2) The signal data converter and receiver-transmitter-antenna are tested by setting the MODE switch to the TEST position. Failure of the signal data converter or receiver-transmitter-antenna is displayed on the computer-display unit by illumination of the MAL indicator lamp, and identification of the failed unit is indicated by a code on the display panel of the computer-display unit.

(3) Continuous monitoring of the signal data converter and receiver-transmitter-antenna is provided by the MEM indicator lamp. The MEM indicator lamp will light in normal operation when the aircraft is flown over smooth water. However, if the lamp remains lighted for more than 10 minutes over land or rough water, then a malfunction exists in the navigation set, and the operator should set the MODE switch to TEST to determine the nature of the failure.

(4) The operator can test the display portion of the computer-display unit by illuminating all the lamp segments in each alphanumeric and numeric readout in the LAMP TEST mode. Keyboard operation is verified by observing the alphanumeric readout as the keyboard is exercised.

3-5. General Keyboard Operating Procedures

a. *Panel Display and Keyboard Operation.* The panel display consists of three displays: Left, right, and center. The left and right or all three may be used, depending on the data to be displayed. In all data displays, except UTM coordinates and DIST/BRG/TIME, the two fields of control are the left and right display panels. In all data entries except UTM coordinates, the fields for data entry are the left and right panels. In UTM coordinate data entry, the first field of control is the center panel and the second field of control is a combination of the left and right panels. When pressing the KYBD pushbutton for the first time in an entry procedure, the keyboard lights, the TGT STR display blanks, and the left, center, and right displays freeze. Pressing the KYBD pushbutton a second time blanks the display panel under control (the center display, if UTM coordinates are to be entered); the left display for all other cases. If it is not desired to change the display in the panel section under control, the pilot can advance to the next field of the display panel by pressing the KYBD pushbutton again. Refer to table 3-2 for types and ranges of data displayed on the computer-display unit.

b. *Data Entry.* To enter a number, press the corresponding key. To enter a letter, first press the key corresponding to the desired letter; then press a key in the left, mid, or right column corresponding to the position of the letter on the pushbutton. For example; to enter an L, first press L, then either 3, 6, or 9 in the right column.

c. *Keyboard Correction Capability.* The last character entered may be cleared by pressing the CLR key. That character may be a symbol or an alphanumeric character. However, if the CLR key is pressed twice in succession, all characters of the field under control will be cleared and that field will still remain under control.

Table 3-2. Computer-Display Unit Data Displays

Switch Position	Center display		Left display		Right display	
	Data	Range	Data	Range	Data	Range
WIND SP/DIR			Windspeed	999km/h	Wind Direction	350°
XTK/TKE			Crosstrack Distance Error.	L/R 999.9 km	Track Angle Error.	R/L 180°
GS/TK			Groundspeed	999 km/h	Track	359°
PP UTM	UTM Zone	(2)	Area/Easting	WV(3) 9999	Northing	9999
LAT/LONG			Latitude	N 84° 00.0' S 80° 00.0'	Longitude	E/W 180° 00.0'
DIST/BRG/TIME	Time	99.9 Min.	Distance to Go.	999.9 km	Bearing	359°
DEST/TGT UTM	UTM Zone	(2)	Area/Easting	WV(3) 9999	Northing	9999
LAT LONG			Latitude	N 84° 00.0' S 80° 00.0'	Longitude	E/W 180° 00.0'
SPH/VAR			Spheroid	(1)	Variation (4).	E/W 180°

LEGEND:

(1) Spheroids include:

Name	Code
Clarke 1866	CL6
Clarke 1880	CL8
International	IN0
Bessel	BE0
Everest	EV0
Australian National	AU0

(2) Numeric: 01-60.

Alpha: C-X, except I and O.

(3) Typical 100 km Designator:

Column Designator: A-Z, except I and O.

Row Designator: A-V, except I and O.

(4) Variation Displayed is for destination indicated by DEST DISP thumbwheel.

d. Destination Magnetic Variation Constraint.
The magnetic variation of a destination must be entered after the associated destination coordinates are entered (because each time a destination is entered, its associated variation is deleted). The order of entry for present position is irrelevant.

e. Impossibility of Entering Unacceptable Data.
In most cases, the computer program will reject unacceptable data. (For example, a UTM area of W1 does not exist, and will be rejected.) If the operator attempts to insert unacceptable data, the unacceptable data will be displayed on the panel and then the display will be blank after the ENT key is pressed.

NOTE

The computer cannot prevent insertion of erroneous data resulting, for example, from human errors or map errors.

NOTE

Erroneous data will be generated when

latitude entry is greater than N84° or S80°.

3-6. General Data Entry Procedures

a. Procedures for entering Spheroid and/or Variation (fig. 3-1).

(1) Set the MODE switch to UTM (LAT/LONG OR BACKUP position may also be used).

(2) Set the DISPLAY switch to SPH/VAR.

(3) Rotate the DEST DISP thumbwheel to the position desired (P for present position, numeral or H for destination).

(4) Press the KYBD pushbutton. Observe that the display freezes and the target store indicator blanks. Press the KYBD pushbutton again and observe that the left display blanks. (If no spheroid data are to be entered, press the KYBD pushbutton again and proceed to (6) below.)

(5) Entry of spheroid data in left display: Consider as an example, entry of IN0, the code for the International spheroid. Press keys 3, 3, 5, 5, and 0.

The display indicates (INO). If magnetic variation data are to be entered, press the KYBD pushbutton. Observe that the right display blanks. If no magnetic variation data are to be entered, press the ENT key.

(6) Entry of variation: Consider as an example entry of a variation of E001.2. Press keys 2, 2, 0, 0, 1 and 2. The display indicates (INO E 001.2).

(7) Press the ENT key. The entire display will blank out for less than 1 second and the TGT STR number will reappear. The display indicates (INO E 001.2).

b. Procedure for Entering Present Position or Destination in UTM. (fig. 3-1).

(1) Set the MODE switch to UTM.

(2) Set the DISPLAY switch to DEST/TGT.

(3) Rotate the DEST DISP thumbwheel to the desired position (P for present position, numeral or H for destination).

(4) Entry of present position or destination: As an example, consider entry of zone 31T, area CF, easting 0958 and northing 3849. Press the KYBD pushbutton. Observe that the display freezes and the target store indicator blanks.

(5) To enter zone 31T, press the KYBD pushbutton. Observe that the center display blanks. Press keys 3, 1, 7, 8.

(6) To enter area CF, easting 0958 and northing 3849, press the KYBD pushbutton. Observe that the left and right displays blank. Press keys 1, 3, 2, 3, 0, 9, 5, 8, 3, 8, 4, and 9.

(7) Press the ENT key. The three displays will blank out for less than 1 second and the TGT STR number will reappear. The displays indicate CF0958 3849 (left and right display) and 31T (center display).

c. Procedure for Entering Present Position or Destination in Latitude/Longitude (fig. 3-1).

(1) Set the MODE switch to LAT/LONG.

(2) Set the DISPLAY switch to DEST/TGT.

(3) Rotate the DEST DISP thumbwheel to the desired position (P for present position, numeral or H for destination).

(4) Entry of present position or destination: As an example, consider entry on N41° 10.1 minutes and E035° 50.2 minutes. Press the KYBD pushbutton. Observe that the display freezes and the TGT STR number indicator blanks. Press the KYBD pushbutton again and observe that the left display blanks.

(5) To enter latitude, press keys, 5, 5, 4, 1, 1, 0 and 1.

(6) To enter longitude, press the KYBD pushbutton (right display will blank) and keys 2, 2, 0, 3, 5, 5, 0 and 2.

(7) Press the ENT key. The entire display will

blank out for less than 1 second and the TGT STR number will reappear. Display indicates N41°10.1E035°50.2.

d. Procedure for Selecting a Destination (fig. 3-1).

(1) Rotate FLY-TO DEST thumbwheel to the destination number that is to be selected.

(2) The computer-display unit then computes crosstrack and track error (XTK/TKE) and distance, bearing, and time (DIST/BRG/TIME) for the selected destination, and the appropriate data will be displayed on the computer-display unit front panel when the DISPLAY switch is set to XTK/TKE or DIST/BRG/TIME.

e. Procedure for Entering Windspeed and Direction (fig. 3-1).

NOTE

The system will accept an entry of windspeed and direction only when a true airspeed sensor is interconnected with the navigation set. If the operator sets the DISPLAY switch to WIND SP/DIR and an asterisk is displayed in each display, this condition indicates that the true airspeed sensor is not interconnected with the navigation set.

NOTE

The direction of the wind is defined as that direction it originates from true North.

(1) Set the MODE switch to BACKUP.

(2) Set the DISPLAY switch to WIND SP/DIR.

(3) Entry of windspeed and direction: As an example, consider the entry of 50 km/h and 130 degrees. Press the KYBD pushbutton. Observe that the left display freezes and the TGT STR number indicator blanks.

(4) To enter windspeed, press the KYBD pushbutton and observe that the left display blanks. Press 0, 5, and 0. Left display indicates 050.

(5) Press the KYBD pushbutton. Control shifts to the right display and the right display blanks.

NOTE

As a result of round off operations in the computer, the entry of 130° wind direction will result in a display of 129° wind direction in the right display when the ENT pushbutton is pressed. A difference of 1° will also result for some but not all wind direction entries.

(6) To enter wind direction, press keys 1, 3 and 0.

(7) Press the ENT key. The entire display will

blank out for less than 1 second, and the TGT STR number will reappear. Displays indicate 050 130°.

f. Procedure for Entering Groundspeed and Track (fig. 3-1).

(1) Set the MODE switch to BACKUP.

(2) Set the DISPLAY switch to GS/TK.

(3) As an example, consider the entry of a groundspeed of 131 km/h and a track angle of 024 degrees. Press the KYBD pushbutton. Observe that the left display freezes and the TGT STR number indicates blanks.

(4) To enter groundspeed, press the KYBD pushbutton and observe that the left display blanks. Press keys 1, 3, and 1. Left displays indicates 131.

(5) Press the KYBD pushbutton. The control shifts to the right display and the right display blanks.

(6) To enter the track angle, press keys 0, 2, and 4.

(7) Press the ENT key. The entire display will blank out for less than 1 second, and the TGT STR number will reappear. Display indicates 131 024°.

3-7. Preflight Procedures

a. System Turn-on.

(1) Pull out the MODE switch knob and set the switch to LAMP TEST; verify the correct operation of all display lamps (fig. 4-1).

(2) Set the MODE switch to TEST and verify that in approximately 15 seconds GO is displayed in the left display and the right display is blank.

(3) Set the MODE switch to the desired coordinate system (UTM or LAT/LONG).

(4) Enter the spheroid of operation if UTM is being used (para 3-6a).

(5) Enter destinations in UTM (para 3-6b) or LAT/LONG (para 3-6c) coordinates as desired.

(6) Enter associated destination variations as desired (para 3-6a). Variations of at least two destinations (one can be H) must be entered for automatic variation update computations to be performed.

b. System Initialization (fig. 3-1).

(1) Enter the present position variation.

(2) Enter the initial fix position on display by using the DEST/TGT position of the DISPLAY switch and the P on the DEST DISP thumbwheel, but do not press the ENT key pushbutton until the aircraft is setting over the initial fix position or is over the initial fix position after takeoff.

(3) Rotate the FLY-TO-DEST thumbwheel to the desired destination location.

3-8. Flight Procedures

a. Updating Present Position from Stored Destination (fig. 3-1). As an example, assume that the aircraft is flying to a destination, that is, the

FLY-TO-DEST thumbwheel is set to the number of the desired destination.

(1) Set the DISPLAY switch to DIST/BRG/TIME. Range, bearing, and time-to-go to the fly-to destination are displayed.

(2) When the aircraft is over the destination, press the KYBD pushbutton. Observe that the display freezes.

(3) To effect position update, press the ENT key. In this instance, the computer updates the present position at the time the KYBD pushbutton was pressed by using the stored destination coordinates, and adding to them the distance traveled between the time the KYBD pushbutton was pressed and released and the ENT key was pressed. In addition, if an associated variation for the stored destination exists, the present position variation is also updated.

(4) If a present position update is unnecessary (as indicated by an appropriately small value of distance to go upon arriving over the destination), set the DISPLAY switch to some other position; this action aborts the update mode.

b. Updating Present Position from a Landmark.

There are two methods for updating present position from a landmark. Method 1 ((1) below) is useful when the landmark comes up unexpectedly and the operator needs time to determine the coordinates. Method 2 (2) below) is useful when a landmark update is anticipated.

(1) Method 1 (fig. 3-1).

(a) Set the DISPLAY switch to PP.

(b) Overfly the landmark and press the KYBD pushbutton. Observe that the present position display freezes.

(c) Compare the landmark coordinates with those on display.

(d) If the difference warrants an update, enter the landmark coordinates by use of the keyboard, and press the ENT key. The computer updates the present position, to the landmark coordinates, and adds to the updated present position the distance traveled between the time the KYBD pushbutton was pressed and ENT key was pressed.

(e) If an update is not desired, set the DISPLAY switch to some other position. This action aborts the update mode.

(2) Method 2 (fig. 3-1).

(a) Set the DISPLAY switch to DEST/TGT.

(b) Rotate the DEST DISP thumbwheel to position P. Observe that the present position coordinates are displayed.

(c) Press the KYBD pushbutton. Observe that the display freezes.

(d) Manually enter the landmark coordinates with use of the keyboard.

(e) When arriving over the landmark, press the ENT key.

(f) To abort this update, set the DISPLAY switch to some other position.

c. Fly-to Destination Operation.

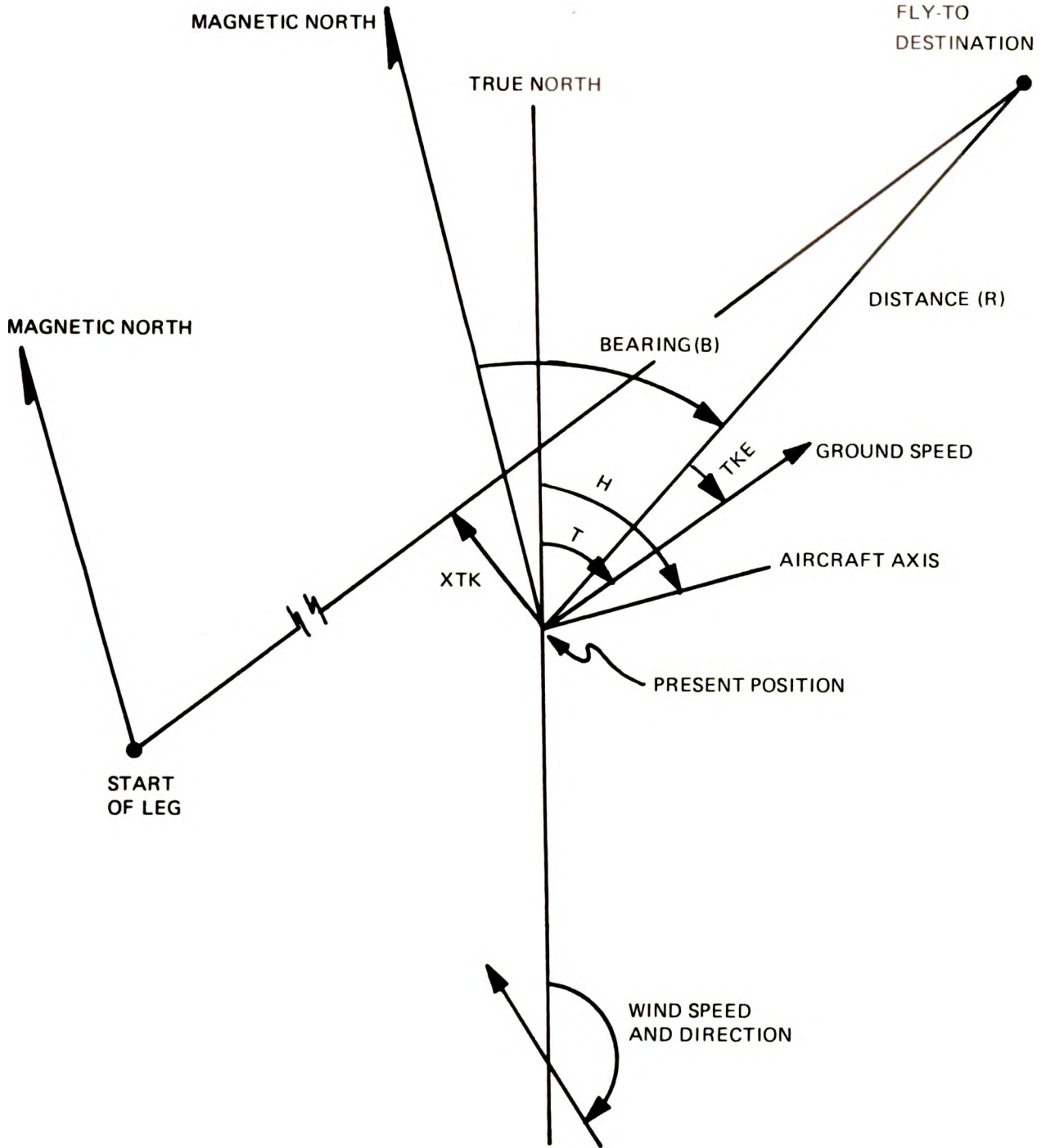
(1) Initialization of desired course.

(a) When a fly-to destination is selected, the present position at the time is stored in the computer. A course is then computed between the selected point and the destination. If the aircraft deviates from this desired course, the lateral offset

cross-track error (XTK) is computed.

(b) Range and bearing to destination, current track made good, and track error correction are computed from present position to destination. Refer to figure 3-2 for a graphic definition of these terms.

(c) In order to provide accurate latitude and longitude coordinate locations, the input to the AN/ASN-128 from an external gyromagnetic compass system or equivalent, must be accurate to one degree.



- XTK - CROSTRACK DISTANCE ERROR
- TKE - TRACK ANGLE ERROR
- B - BEARING TO DESTINATION
- T - TRACK MADE GOOD
- R - DISTANCE FROM PRESENT POSITION TO FLY-TO-DESTINATION
- H - HEADING

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Figure 3-2. Fly-to-Destination Calculations, vector diagram.

(2) *Left-Right Steering Signals* (fig. 3-1).

(a) The pilot may fly to destination using left-right steering signals displayed on the computer-display unit. Left-right steering signals may be used when flying the shortest distance to destination from present position ((b) below) or when flying a ground track ((c) below).

(b) When flying the shortest distance to destination from present position, set the DISPLAY switch to DIST/BRG/TIME and steer the vehicle to the bearing displayed. As an aid to maintaining course, set the DISPLAY switch to XTK/TKE, and steer the vehicle to keep track angle error (TKE) nominally zero. If the display indicates an L (left) TKE, the aircraft must be flown to the left to zero the error.

(c) When flying a ground track, set the DISPLAY switch to XTK/TKE. Steer the vehicle to obtain zero for crosstrack error (XTK) and track angle error (TKE). If XTK is left (L), aircraft is to the right of the desired course and must be flown to the left to regain the initial course.

d. Target Store (TGT STR) Operation. Two methods may be used for target store operation. Method 1 ((1) below) is normally used when time is not available to preplan a target store operation. Method 2 ((2) below) is used when time is available and it is desired to store a target in a specific location.

(1) *Method 1* (fig. 3-1).

(a) Press the TGT STR pushbutton while flying over the target.

(b) Present position is automatically stored and the destination location is that which was displayed in the target store indicator (positions 6, 7, 8, or 9) immediately prior to pressing the TGT STR pushbutton.

(2) *Method 2* (fig. 3-1).

(a) Set the MODE switch to UTM or LAT/LONG, depending on coordinate format desired.

(b) Set the DISPLAY switch to DEST/TGT.

(c) Rotate the DEST DISP thumbwheel to position P.

(d) Press the KYBD pushbutton when overflying the potential target. Observe that the display freezes.

NOTE

Do not press the ENT key while the DEST DISP thumbwheel is at position P.

(e) To store the target, rotate the DEST DISP thumbwheel to the destination location desired and press the ENT key.

(f) If the target is not to be stored, set the DISPLAY switch momentarily or permanently to another position.

e. Procedure for Transferring Stored Target Coordinates from One Location to Another (fig. 3-1). The following procedure allows the operator to transfer stored target coordinates from one location to another. For illustrative purposes, assume that the operator wants to put the coordinates of stored target 7 into the location for destination 2.

(1) Set the DISPLAY switch to DEST/TGT.

(2) Rotate the DEST DISP thumbwheel to position 7.

(3) Press the KYBD pushbutton.

(4) Rotate the DEST DISP thumbwheel to position 2.

(5) Press the ENT key.

f. Procedure for Transferring Variation from One Location to Another (fig. 3-1). The following procedure allows to operator to transfer variation data to the same locations where the associated stored target coordinates have been transferred. For illustrative purposes only, assume that the operator wants to put variation data associated with stored target location 7 into location for destination 2.

(1) Set the DISPLAY switch to SPH/VAR.

(2) Rotate the DEST DISP thumbwheel to position 7.

(3) Press the KYBD pushbutton.

(4) Rotate the DEST DISP thumbwheel to position 2.

(5) Press the ENT key.

g. Procedure for Shutdown. After completion of the flight, set the MODE switch to OFF and set the aircraft navigation system circuit breakers to off.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

3-9. Flight Operation in Backup Mode

The navigation set is capable of providing useful navigational data even though Doppler velocity data is lost due to a failure or is invalid because the aircraft is flying over extremely smooth water. Depending on whether or not true airspeed is

available, there are two procedures for operation in the backup mode. When the optional true airspeed input is available, the basic backup mode is air data navigation. The operator can determine if true airspeed is available by setting the DISPLAY switch to WIND SP/DIR and observing the display. The

left display will indicate windspeed and the right display will indicate direction. This is a normal display and true airspeed is available. If an asterisk is displayed in the left and right displays, then true airspeed is not available. If true airspeed is available, use the backup mode procedure described for air data navigation (*a* below). If true airspeed is not available, then use the backup mode procedure described for dead reckoning navigation (*b* below).

a. Air Navigation (fig. 3-1). The air data navigation in the backup mode is accomplished by using true airspeed plus remembered or keyboard updated wind data; remembered wind data was computed during normal Doppler navigation operation. Wind data may be updated in the backup mode only. In the backup mode, display and entry of present position and destination data are limited to UTM coordinate format.

(1) Set the MODE switch to BACKUP. The computer will navigate based on air data.

(2) If updated wind data becomes available, it can be inserted by means of the keyboard with the DISPLAY switch in the WIND SP/DIR position. The computer will navigate based on these inputs. To abort this mode, place the MODE switch out of the BACKUP position.

b. Dead Reckoning Navigation (fig. 3-1). As an alternate backup mode, dead reckoning navigation can be performed using groundspeed and track angle estimates provided by the operator and inserted with KYBD pushbutton and keyboard.

(1) Set the MODE switch to BACKUP.

(2) Set the DISPLAY switch to GS/TK and en-

ter the best estimates of groundspeed and track angle. The computer will navigate based on these inputs. To abort this mode, place the MODE switch out of the BACKUP position.

3-10. Operation Under Emergency Conditions

a. Operation During and After Power Interruption. During power interruption, the stored destination data and present position are retained by power from a dry cell battery. This condition makes it unnecessary to reenter any navigation data when power returns. Navigation will be interrupted during the absence of power and the present position should be updated if the duration of the power failure warrants it.

(1) If the battery fails to retain the stored destination data during power interruption, the display will indicate only EN, when power returns, which is an indication to the operator that previously stored data has been lost and present position spheroid/variation, and destinations, must be entered.

(2) During battery failure, the computer, upon return of power, initializes present position variation to E000.0°, destinations and associated variations to a nonentered state, remembered wind to zero, and spheroid to Clarke 1866.

(3) The following data must be entered following battery failure.

(a) Spheroid.

(b) Present position variation.

(c) Present position.

(d) Each destination and its associated variation.

CHAPTER 4

OPERATOR/CREW MAINTENANCE INSTRUCTIONS

Section I. GENERAL

4-1. Scope of Operator/Crew Maintenance

Maintenance instructions covered in this chapter are limited to operator/crew maintenance. Organizational maintenance for the three units of the navigation set is provided in chapter 5. The maintenance duties assigned to the operator/crew

are listed below, with a reference to the specific maintenance function. Special tools or test equipment are not required.

- a. Preventative maintenance (para 4-2).
- b. Operational checkout (para 4-3).
- c. Troubleshooting (para 4-4).

Section II. PREVENTATIVE MAINTENANCE CHECKS AND SERVICES

4-2. General

To be sure that Doppler Navigation Set AN/ASN-128 is always ready for operation, a systematical inspection is necessary so that defects may be discovered and corrected before damage or failure occurs. The preventative maintenance checks and services are listed and described in table 4-1. The sequence numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit will be noted and corrective action taken as soon as operation has ceased. Record all deficiencies together with the corrective action taken, as prescribed in TM 38-750.

4-3. Operational Checkout Procedure

The following procedure uses the navigation set self-test BITE (built-in test equipment) to verify the operational readiness of the equipment. If the correct response is not obtained, refer the malfunction to the next higher maintenance category for corrective action.

a. Activate aircraft power to provide the following:

- (1) +28 volts dc.

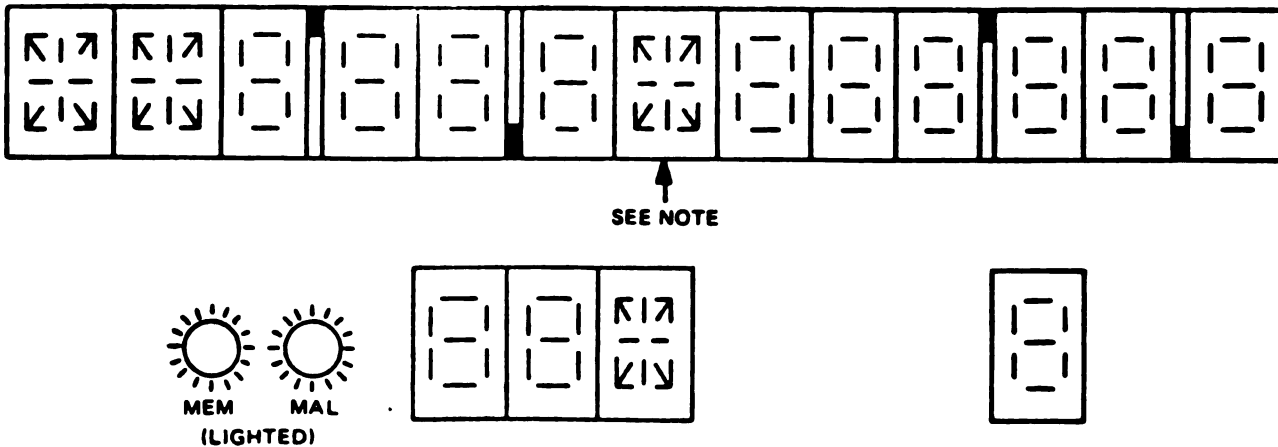
- (2) 26 volt, 400 Hertz synchro reference.
- (3) If aircraft is provided with a DAY-NIGHT switch, set the switch to the NIGHT position.
- (4) 5 volts (ac or dc) for edge lighting.

NOTE

For the operational checkout, it is necessary to activate the vertical gyro for pitch and roll data, and provide heading data from the magnetic compass. It may be necessary to use a hood during daylight to verify all lighting requirements.

b. At the computer-display unit (fig. 3-1), set the MODE switch to LAMP TEST and turn DIM control fully clockwise (CW). Verify the following:

- (1) The left, right, and center displays and target storage indicator displays are lighted as shown in figure 4-1.
- (2) MEM and MAL indicator lamps are lighted.
- (3) All edge lighting illuminates entire front panel.
- (4) The TGT STR, KYBD, CLR, ENT, all keyboard pushbuttons, the FLY-TO DEST, and DEST DISP indicators are lighted.



NOTE: EXCEPT DURING LAMP TEST, FIRST CHARACTER OF RIGHT DISPLAY SHOWS ALPHAS OR BLANKS ONLY.

EL2SL010

Figure 4-1. Lamp Test Displays.

c. Turn DIM control fully counterclockwise (CCW) then fully CW. All segments of the displays shall extinguish, and glow brightly. The MEM and MAL indicator lamps shall be lighted.

resulting random displays which may appear for up to 15 seconds. After approximately 15 seconds, the first two character positions in the left display will display GO.

d. Set the MODE switch to TEST. Ignore the

Section III. TROUBLESHOOTING

4-4. General

Troubleshooting the navigation set at operator/crew maintenance is limited to recognizing that a malfunction exists, and then referring that malfunction to the next higher category of maintenance for further checkout and corrective action. Lighting and display malfunctions can be observed by not getting the required indications described in paragraph 4-3b and c of the operational checkout procedure. Other malfunctions can be observed when the MODE switch of the computer-display unit is set to TEST. Table 4-2 shows the possible

codes which may be displayed when this operation is performed.

NOTE

If the MAL lamp lights during any mode of operation except LAMP TEST, the computer-displayed unit MODE switch should be first set to the OFF position and then to TEST to verify the failure. If the MAL lamp remains lighted after recycling to the TEST position, notify organizational maintenance personnel of the navigation set malfunction.

Table 4-1. Operator/Crew Preventative Maintenance Checks and Services
B— Before Operation **D— During Operation** **A— After Operation**
 Time reqd: 0.4 hrs. Time reqd: 0/2 hrs. Time reqd: 0.3 hrs.

Internal and sequence No.			Item to be inspected Procedure	Work time (M/H)
B	D	A		
1		1	EXTERIOR SURFACES Remove all dirt, dust, and moisture from the exterior surface of the computer-display unit: Use a clean dry cloth.	0.1
2		2	MOUNTING Inspect mounting of computer-display unit. Check for loose or missing hardware.	0.1
3	1	3	CONTROLS AND SWITCHES Check to see that each control and switch functions properly. Mechanical action of each control or switch should be smooth and free from external or internal binding.	0.1
4	2		OPERATIONAL CHECKOUT Perform the operational checkout procedure (para 4-3)	0.1

Table 4-2. Operator/Crew Troubleshooting

Left Display	Right Display	Remarks
GO	No display. Display blanks (normal).	If right display is blank; system is operating satisfactorily.
GO	P	If right display is P, then pitch or roll data is missing; or pitch exceeds 90°. In this case; pitch and roll in the computer are both set to zero and navigation continues in a degraded operation. Problem may be in the vertical gyroscope or aircraft cabling.
BU	C, R, S, or H followed by a numeric code.	A failure has occurred and the system has automatically switched to a backup mode of operation as follows: (1) If no true airspeed is available, BU will never be displayed. Last remembered velocity is being used for navigation. The operator has the option of setting the MODE switch to BACKUP and entering the best estimate of groundspeed and track angle. (2) If true airspeed is available, true airspeed plus remembered wind is used for navigation. The operator has the option of setting the MODE switch to BACKUP and enter the best estimate of windspeed and direction, or, if the accuracy of the true airspeed is questionable, enter the best estimate of the groundspeed and track angle. The operator should update present position as soon as possible, because it is possible that significant navigation errors may have accumulated.
MN	C, R, S, or H followed by a numeric code.	A failure has occurred and the BACKUP mode, used for manual navigation (MN), is the only means of valid navigation. The operator may use the computer as a dead reckoning device by entering groundspeed and track data. The operator should update present position as soon as possible, because significant navigation errors may have accumulated.
NG	C, R, S, or H followed by a numeric code.	A failure has occurred in the computer-display unit, and the operator should not use the system.
EN	No display. Display blanks.	If this display appears after turn-on of Mode switch, the CDU battery has failed and navigation data have been lost from memory. Press KYBD pushbutton, recycle system power, then reenter data, using general data entry procedures. Have battery replaced at first opportunity.

CHAPTER 5

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. TOOLS, TEST EQUIPMENT, AND MATERIALS

5-1. Tools and Test Equipment

Tools and test equipment required for organizational maintenance of the navigation set are listed below. Organizational maintenance repair parts and special tools are listed in TM 11-5841-281-20P.

- a. *Tools.* Tool Kit TK-101/G (NSN 5180-00-064-5178)
- b. *Test Equipment.* No test equipment required.

5-2. Materials Required

- a. Trichloroethane.
- b. Camel hair brush (NSN 8020-00-242-9625).
- c. Lint-free cloth (NSN 8305-00-170-5062).
- d. Sandpaper, fine (NSN 5350-00-264-3485).
- e. Primer, zinc chromate.
- f. Paint, black (No. 37038 per MIL-STD-595).
- g. Foam rubber pad (1 piece, 2 ft by 2 ft and 2 in.).

Section II. REPAINTING AND REFINISHING INSTRUCTIONS

5-3. Repainting and Refinishing Instructions

a. Perform cleaning procedures given in paragraph 5-5; finish by performing procedure 5-5b in area to be painted. Allow equipment to dry thoroughly.

b. Apply one coat of zinc chromate primer to bare metal surfaces.

c. Apply one coat of black lusterless enamel (No. 37038 per MIL-STD-595) to area to be painted.

Allow to dry thoroughly.

NOTE

Refer to TB 43-0118 and SB 11-573 for procedures and material required.

CAUTION

Do not paint or allow paint or any preservative to contaminate the bottom of the antenna (radome).

Section III. PREVENTATIVE MAINTENANCE CHECKS AND SERVICES

5-4. General

To be sure that Doppler Navigation Set AN/ASN-128 is always ready for operation, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preven-

tative maintenance checks and services are listed and described in table 5-1. The sequence numbers indicate the sequence of minimum inspection requirements. Record all deficiencies together with the corrective action taken as prescribed in TM 38-750.

Table 5-1. Organizational Preventative Maintenance Checks and Services

W—Weekly or as required
Total task-hours reqd: 0.25

M—Monthly
Total task-hours reqd: 1.1

Sequence number	Item to be inspected Procedure	Work time (T/H)
1	ANTENNA RADOME Remove all dirt, grease, and moisture from antenna radome (para 5-5). Inspect radome for cracks and signs of deterioration.	0.25
2	EXTERIOR SURFACES Remove all dirt, grease, and moisture from all exterior surfaces as required (para 5-5). Check general condition of each component.	0.5
3	MOUNTINGS Inspect mounting of each component. Check for loose or missing hardware and tighten as necessary.	0.2
4	CABLE CONNECTORS AND BATTERY Check all connectors to all components of the navigation set and be sure that they are clean, intact, and tight (para 5-5). Remove the computer-display unit from the console (para 5-12 a, b, and c), remove battery cover (para 2-5a(2)) and inspect battery for corrosion and bulging.	0.25
5	CONTROLS AND SWITCHES Check for proper mechanical action (positive action without backlash, bind, or scraping).	0.1
6	OPERATIONAL CHECKOUT Perform operational checkout procedures (para 5-6 and 5-7).	0.1

5-5. Cleaning

The exterior of the navigation set components should be free from moisture, dirt, grease, and corrosion.

WARNING

Adequate ventilation should be provided while using TRICHLOROTRIFLUOROETHANE. Prolonged breathing of vapor should be avoided. The solvent should not be used near heat or open flame; the products of decomposition are toxic and irritating. Since TRICHLOROTRIFLUOROETHANE dissolves natural oils, prolonged contact with skin should be avoided. When necessary, use gloves which the solvent cannot penetrate. If the solvent is taken internally, consult a physician immediately.

- a. Remove moisture and loose dirt with a clean cloth.
- b. Remove grease, corrosion, and ground-in dirt from metal surfaces with a cloth dampened (not wet) with trichlorotrifluoroethane. Wipe dry with a clean, lint-free cloth.
- c. Remove dirt from the connectors with a brush; remove moisture with a dry cloth.
- d. Remove rust from metal surfaces by lightly sanding with fine sandpaper.

5-6. Operational Checkout Procedure

The following procedure uses the navigation set self-test BITE (built-in test equipment) to verify the operational readiness of the equipment. If the

correct response is not obtained, refer to the troubleshooting table (para 5-8b) for corrective action. Refer to paragraph 5-7 for checkout of the operating controls and keyboard.

a. Activate aircraft power to provide the following:

- (1) +28 volts dc.
- (2) 26 volt, 400 Hertz synchro reference.
- (3) If aircraft is provided with a DAY&NIGHT switch, set to NIGHT position.
- (4) 5 volts (ac or dc) for edge lighting.

NOTE

For the operational checkout, it is necessary to activate the vertical gyro for pitch and roll data, and provide heading data from the magnetic compass.

NOTE

It may be necessary to use a hood during daylight to verify all lighting requirements.

b. At the computer-display unit (fig. 3-1) turn the DIM control clockwise (CW) and set the MODE switch to LAMP TEST. (To operate the MODE switch from OFF, the knob must be pulled forward). Adjust the DIM control to the desired level. Verify the following:

- (1) The left, right, and center displays; and target storage indicator displays are lighted as shown in figure 4-1.
- (2) MEM and MAL indicator lamps are lighted.
- (3) All edge lighting illuminates entire front panel.
- (4) The TGT, STR, KYBD, CLR, ENT, all

keyboard pushbuttons, the FLY-TO DEST, and DEST DISP indicators are lighted.

c. Set the MODE switch to TEST. Ignore the random displays which may appear for up to 15 seconds after setting the MODE switch to TEST. After approximately 15 seconds, the first two character positions in the left display will display GO.

5-7. Front Panel Switches and Keyboard Checkout

The procedures given below verify operation of the front panel switches and the keyboard keys. In the displays below, the letter A indicates any letter is acceptable in this location, and the letter X indicates any number is acceptable. If any abnormal result is obtained, replace the computer-display unit (para 5-12).

a. Set the MODE switch to LAMP TEST and turn the DIM control fully CW, then fully CCW, and return to full CW position; all segments of the segmented displays will alternately glow bright, extinguish, and glow bright, and the MEM and MAL indicator lamps will light.

b. Set the MODE switch to UTM and the DISPLAY switch to WIND SP/DIR.

(1) If a true airspeed sensor is not provided on the aircraft, two asterisks (*) will be displayed, one in the left display and one in the right display.

(2) If TAS is available, the left and right displays will be lighted as follows:

XXX XXX°

c. Set the DISPLAY switch to XTK/TKE. The left and right displays will be lighted as follows:

R (or L) R(or L)
XXX.X X XXX°

NOTE

Left display may be an asterisk.

d. Set the DISPLAY switch to PP. The left, right, and center displays will be lighted as shown:

AAXXX XXXX
XXA

e. Set the DISPLAY switch to DEST/TGT and the DEST DISP thumbwheel to P. The left, right, and center displays will be lighted as follows:

AXXX XXXX
XXA

f. Set the MODE switch to LAT/LONG. The left and right displays will be lighted as follows:

N (or S) E (or W)
XX°XX.X XXX°XX.X

g. Set the MODE switch to BACKUP. The left, right, and center displays will be lighted as follows:

AAXXX XXXX
XXA

h. Set the DISPLAY switch to SPH/VAR. The left and right displays will be lighted as follows:

AAO E (or W)
or AA6 XXX.X

i. Set the DISPLAY switch to DEST/TGT and the DEST DISP thumbwheel to P. Proceed as follows:

(1) Press the KYBD pushbutton twice, and the keyboard keys 1, 2, 4, and 6. The center display readout will be 12L.

(2) Press the CLR pushbutton. The center display readout will be 12 (L clears).

(3) Press keys 2 and 1. The center display readout will be 12D.

(4) Press the CLR pushbutton twice. The center display will clear.

(5) Press the KYBD pushbutton and keys 2, 1, 4, 6, 5, 6, 7, 8, 9, 0, 1, and 2. The readout on the left and right displays will be DL5678 9012.

j. Set the DISPLAY switch to GS/TK. Press the following pushbuttons and keys in the given order: KYBD, KYBD, 0,0,0, KYBD, 0,0,0, and ENT. The left and right displays will be lighted as follows:

000. 000°

NOTE

Performance of k through m below will remove all stored destination coordinate data.

k. Set the DISPLAY switch to SPH/VAR. Press the following pushbuttons and keys in the given order: KYBD, KYBD, 1,3,4,6,0, KYBD, 2,2,0,0,0,0, and ENT. The left and right displays will be lighted as follows:

CLO E000.0

l. Set the DISPLAY switch to DEST/TGT and proceed as follows:

(1) Set the DEST DIST thumbwheel to P. Press the following pushbuttons and keys in the given order: KYBD, KYBD, 3, 1, 5, 5, KYBD, 2,2,5,4,0,0,0,0,0,0,0,0, and ENT. The left, right, and center displays will be lighted as follows:

EM0000 31N 0000

(2) Set DEST DISP thumbwheel to 1. Press the following pushbuttons and keys in the given order: KYBD, KYBD, 3, 1, 5, 5, KYBD, 2, 2, 4, 6, 0, 0, 0, 0, 9, 0, 0, 0, and ENT. The left, right, and center displays will be lighted as follows:

EL0000 31N 9000

(3) Press the KYBD pushbutton, set the DEST DISP thumbwheel to 3, and press the ENT pushbutton. The display will be as specified in (2) above.

(4) Press the KYBD pushbutton, set the DEST DISP thumbwheel to 5, and press the ENT key

pushbutton. The display will be as specified in (2) above.

(5) Press the KYBD pushbutton, set the DEST DISP thumbwheel to 7, and press the ENT key pushbutton. The display will be as specified in (2) above.

(6) Press the KYBD pushbutton, set the DEST DISP thumbwheel to 9, and press the ENT key pushbutton. The display will be as specified in (2) above.

(7) Set the DEST DISP thumbwheel to H. Press the following pushbuttons and keys in the given order: KYDB, KYBD, 3, 1, 5, 5, KYBD, 2, 1, 5, 4, 6, 5, 3, 6, 2, 0, 0, 0, and ENT. The left, right, and center display will be lighted as follows:

DM6536 2000

31N

(8) Press the KYBD pushbutton, set DEST DISP thumbwheel to 2, and press the ENT pushbutton. The display will be as specified in (7) above.

(9) Press the KYBD pushbutton, set DEST DISP thumbwheel to 4, and press the ENT pushbutton. The display will be as specified in (7) above.

(10) Press the KYBD pushbutton, set the DEST DISP thumbwheel to 6, and press the ENT pushbutton. The display will be as specified in (7) above.

(11) Press the KYBD pushbutton, set the DEST DISP thumbwheel to 8, and press the ENT

pushbutton. The display will be as specified in (7) above.

(12) Press the KYBD pushbutton, set the DEST DISP thumbwheel to 0, and press the ENT pushbutton. The display will be as specified in (7) above.

m. Set the DISPLAY switch to DIST/BRG/TIME and proceed as follows:

(1) Turn the FLY-TO-DEST thumbwheel to 1, 3, 5, 7, and 9. At each position the left, right, and center displays will be lighted as follows:

010.0 180°

*

(2) Turn the FLY-TO DEST thumbwheel to H, 2, 4, 6, 8, and 0. At each position, the left, right, and center displays will be lighted as follows:

040.0 300°

*

n. Set the DEST DISP thumbwheel to the number displayed in the target storage indicator. Set the DISPLAY switch to DEST/TGT, and press the TGT STR pushbutton.

(1) The left, right, and center displays will be lighted as follows:

EM0000 0000

31N

(2) The number displayed in the target storage indicator will be 1 greater than the number displayed before TGT STR pushbutton was pressed; but if the number was 9, it will be 6.

Section IV. TROUBLESHOOTING

5-8. Troubleshooting Procedures

a. Fault isolation of the navigation set is based on observation of an abnormal result in the operational checkout procedures given in paragraph 5-6. At the organizational category, troubleshooting is limited to fault isolation to one of the three units of the navigation set or the CDU battery, and identification and replacement of a defective keyboard pushbutton lamp, indicator lamp, or digital display indicator (character and/or decimal and degree symbols). Fault isolation to one of the three units is accomplished through use of the computer-display unit. When the MODE switch is set to TEST, the computer-display unit provides a coded display, which identifies the faulty LRU. This display consists of two parts. The left part of the display is a code that indicates to the pilot/operator the appropriate action to be taken (table 4-2), and the right part of the code provides maintenance instructions by identifying the failed LRU. The left part of the display consists of a two-letter code

followed by four blanks. The right part of the display consists of a letter followed by six numerals.

b. *Troubleshooting Tables.* If all lamps do not light during LAMP TEST, refer to table 5-2 for troubleshooting procedures. When an abnormal result is obtained during TEST mode, refer to table 5-3, which relates the displays on the computer-display unit to the proper corrective action required. The failure codes in this table identify the LRU that has the highest probability of failure. However, when the failure occurs in the interface between the LRU's, the BITE cannot positively isolate the fault to the defective LRU or aircraft cable. In such cases it may be necessary to replace a second LRU, and if this does not clear the failure, check out aircraft wiring. Refer to the applicable aircraft electronics equipment configuration manual for complete wiring diagrams of the AN/ASN-128 in a specific aircraft. The interpretation of the initial letter of the failure code is as follows:

CODE INTERPRETATION

- R—RTA defective
- S—SDC defective
- C—CDU defective
- H—Heading function defective
- P—Pitch and/or Roll function defective

Table 5-3 lists the failure codes that can be displayed when only one type of failure occurs. If multiple types of failures occur, more than one non-zero numeric will appear in the failure code; e.g., C001040. If a CDU failure occurred in addition to an SDC failure, the alpha in the failure code would be a C instead of S. This is done to identify the CDU as the defective LRU since its failure precludes system operation. When the CDU computer is defective, it may not be possible to display a failure code. Generally, the display will be frozen (no change in

display when the MODE or DISPLAY switches are moved) or meaningless with the MAL lamp lit.

NOTE

If the MAL lamp lights during any mode of operation except LAMP TEST, the Computer Display Unit MODE switch should be rotated to the TEST position and the malfunction code display recorded. To prevent the possibility of the malfunction being caused by some external intermittent condition, rotate the MODE switch to OFF, then to LAMP TEST for approximately 5 seconds, and then to TEST. If the MAL light comes on again, proceed to table 5-3 for fault identification and corrective action.

Table 5-2. Lamp Test Troubleshooting

Trouble	Corrective action
Letters EN displayed in first two positions of left display.	Press KYBD pushbutton, then set MODE switch to OFF. Wait at least two minutes, then set MODE switch to LAMP TEST. If letters EN are displayed again, replace CDU battery (para 2-5a).
MEM or MAL indicator lamp fails to light.	Replace defective indicator lamp (para 5-15). If malfunction persists, replace CDU (para 5-12).
Lamp illuminating associated pushbutton does not light.	Replace defective pushbutton lamp (para 5-14).
Digital display alphanumeric characters or decimal and degree symbols incorrect or missing.	Replace failed character (para 5-13). If malfunction persists, replace CDU (para 5-12).
Front panel edge lighting lamp out.	Replace light transmitting indicating panel (para 5-15).
FLY TO DEST or DEST DISP indicator lamp out.	Replace CDU (para 5-12).

Table 5-3. Test Mode Troubleshooting

Failure Code	Probable Cause and Corrective Action
R__00000	Defective RTA. Replace RTA. If malfunction persists, check SDC/RTA cable.
S200000	SDC signal processing malfunction. Replace SDC.
S300000	1. SDC A/D conversion malfunction. Replace SDC. 2. SDC malfunction in conjunction with defective RTA or SDC/RTA cable if, after ADC replacement, code R__00000 is displayed. Replace RTA. If trouble persists, check SDC/TA cable.
S400000	1. Malfunction in SDC timing/interface circuits. Replace SDC. 2. SDC malfunction in conjunction with defective RTA or SDC/RTA cable if, after SDC replacement, code R__00000 is displayed. Replace RTA. If trouble persists, check SDC/RTA cable. 3. Defective CDU ^a . Replace CDU. If trouble persists, check SDC/CDU cable.
S500000	SDC signal processing and A/D conversion malfunction. Replace SDC.
S600000	1. SDC signal processing and timing/interface malfunction. Replace SDC. 2. Defective CDU ^a . Replace CDU. If trouble persists, check SDC/CDU cable.
S700000	1. SDC A/D conversion and timing/interface malfunction. Replace SDC. 2. SDC malfunction in conjunction with defective RTA or SDC/RTA cable if, after SDC replacement, code R__00000 is displayed. Replace RTA. If trouble persists, check SDC/RTA cable. 3. Defective CDU ^a . Replace CDU. If trouble persists, check SDC/CDU cable.
S800000	1. Malfunction in SDC signal processing timing/interface and A/D conversion. Replace SDC. 2. Defective CDU ^a . Replace CDU. If trouble persists, check SDC/CDU cable.
S010000	1. SDC timing/interface malfunction. Replace SDC.
S020000	2. Defective CDU ^a . Replace CDU. If trouble persists, check
S030000	SDC/CDU cable.
S040000	
S060000	
S070000	

Table 5-3. Test Mode Troubleshooting—Continued

Failure Code	Probable Cause and Corrective Action
S080000 S050000	<ol style="list-style-type: none"> 1. SDC timing/interface and/or A/D conversion malfunction. Replace SDC. 2. Defective CDU^a. Replace CDU. If trouble persists, check SDC/CDU cable. 3. Loss of 26V, 400 Hz input to SDC. Check input voltage.
S090000	<ol style="list-style-type: none"> 1. SDC timing/interface and/or power supply malfunction. Replace SDC. 2. Defective CDU^a. Replace CDU. If trouble persists, check SDC/CDU cable.
C001000	<ol style="list-style-type: none"> 1. CDU input/output malfunction. Replace CDU. 2. SDC timing/interface malfunction. Replace SDC. If trouble persists, check SDC/CDU cable. CDU input/output malfunction. Replace CDU.
C002000	
C004000	
C005000	
C006000	
C007000	
C000200	CDU computer malfunction. Replace CDU.
C000400	
C000600	
C000020	
C000040	
C000060	
C000001	
C000002	
C000003	
C000004	
C000005	
C000006	
C000007	
H010000	<ol style="list-style-type: none"> 1. Heading reference failure. Check reference heading. 2. SDC A/D conversion malfunction. Replace SDC. 3. Defective aircraft wiring. Check aircraft wiring.
P.....	<ol style="list-style-type: none"> 1. Vertical reference failure. Check vertical reference. 2. SPC A/D conversion malfunction. Replace SDC. 3. Defective aircraft wiring. Check aircraft wiring.

^a It is possible that a deficiency in CDU input/output could cause this failure code because of its interface with the SDC.

Section V. MAINTENANCE OF DOPPLER NAVIGATION SET AN/ASN-128

NOTE

Except for the specified organizational maintenance covered herein, repair and maintenance of the navigation set is covered under a manufacturer's Reliability Improvement Warranty (RIW). Perform only the organizational maintenance procedures specified in this manual. Follow directions on the warranty notice plate attached to each unit. Organizational maintenance personnel verify failures prior to the return of units to the manufacturer, and provide failure date and failure circumstance data. Use appropriate packing and packing when returning units. *Do not*

break or tamper with warranty seals; otherwise warranty will be invalid for that unit.

5-9. General

Organizational maintenance of Doppler Navigation Set AN/ASN-128 is limited to the following replacements:

- a. Signal data converter (para 5-10).
- b. Receiver-transmitter-antenna (para 5-11).
- c. Computer-display unit (para 5-12).
- d. Digital display indicator (para 5-13).
- e. Lamp in keyboard switch actuating lens (para 5-14).
- f. MEM or MAL incandescent lamp (para 5-15).

g. Computer-display unit battery (para 2-5a(2)).

5-10. Signal Data Converter Replacement

Instructions

a. Set the front panel MODE switch on the computer-display unit to OFF. (MODE switch must be pulled forward to be placed in the OFF position.)

b. Disconnect three cable connectors (fig. 2-3) from connectors 1J1, 1J2, and 1J3.

c. Remove the four bolts that secure the unit through mounting lugs at the corners.

d. Remove the unit.

e. Record the date of removal on the installation log plate (fig. 2-2) attached to the unit. The time totalizing meter reading (visible on computer-display unit only) will be recorded by the manufacturer. The data should be recorded with black epoxy ink per MIL-I-43553 and a straight nib pen or equivalent. Allow to air dry at 65° F minimum until the ink is tack free before handling (approximately 30 minutes). No protective spray is required.

f. Install the replacement signal data converter (para 2-5c).

g. Verify navigation set operation by performing the operational checkout (para 5-6).

5-11. Receiver-Transmitter-Antenna Replacement

Instructions

a. Set the front panel MODE switch on the computer-display unit to OFF.

b. Disconnect the cable from connector 2J1 (fig. 2-3).

c. Disconnect the ground strap from the mounting hole (fig. 2-4).

CAUTION

When removing the receiver-transmitter-antenna, be very careful not to damage the alignment pins (fig. 2-4), the mating slots in the mounting bracket, or the sealing compound on the four sides of the receiver-transmitter-antenna.

CAUTION

To prevent damage to the radome surface, the receiver-transmitter-antenna must be placed on a foam rubber pad approximately 2 feet by 2 feet and 2 inches thick (or an equivalent) during bench test, storage, and transportation to and from the aircraft.

d. Remove the eight screws that secure the receiver-transmitter-antenna to the aircraft mounting bracket and remove the unit.

e. Record the date of removal on the installation log plate (fig. 2-2) attached to the unit. Data should be recorded with black epoxy ink per MIL-I-43553 and a straight nib pen (or an equivalent). Allow to air dry at 65° F (18° C) minimum until the ink is

tack free before handling (approximately 30 minutes). No protective spray is required.

f. Install the replacement receiver-transmitter-antenna (para 2-5d).

g. Perform the operational checkout (para 5-6).

5-12. Computer-Display Unit Replacement

Instructions

a. Pull the front panel MODE switch knob out to place it in OFF position.

b. Loosen the eight turnlock fasteners that secure the unit to the control panel.

c. Carefully remove the unit from the control panel until the two connectors on the back of the unit can be reached.

d. Disconnect the two cable connectors (fig. 2-3) from connectors 3J1 and 3J2 and remove the unit.

e. Record the date of removal on the installation log plate (fig. 2-2) attached to the unit. Do not record the time totalizing meter reading. Data should be recorded using black epoxy ink per MIL-I-43553 with a straight nib pen (or an equivalent). Allow to air dry at 65° F (18° C) minimum until the ink is tack free before handling (approximately 30 minutes). No protective spray is required.

f. Install the replacement computer-display unit (para 2-5b).

g. Perform the operational checkout (para 5-6).1

5-13. Digital Display Indicator Replacement

Instructions

(fig. 5-1)

a. Loosen six captive screws (2) and lockwashers (3) that secure the bezel and gasket assembly (1) to the unit.

b. Remove the bezel and gasket assembly and place it in a location where the bezel will not get scratched.

c. Firmly grasp the defective digital display indicator (4, 5 or 6) and pull it out from the front of the unit.

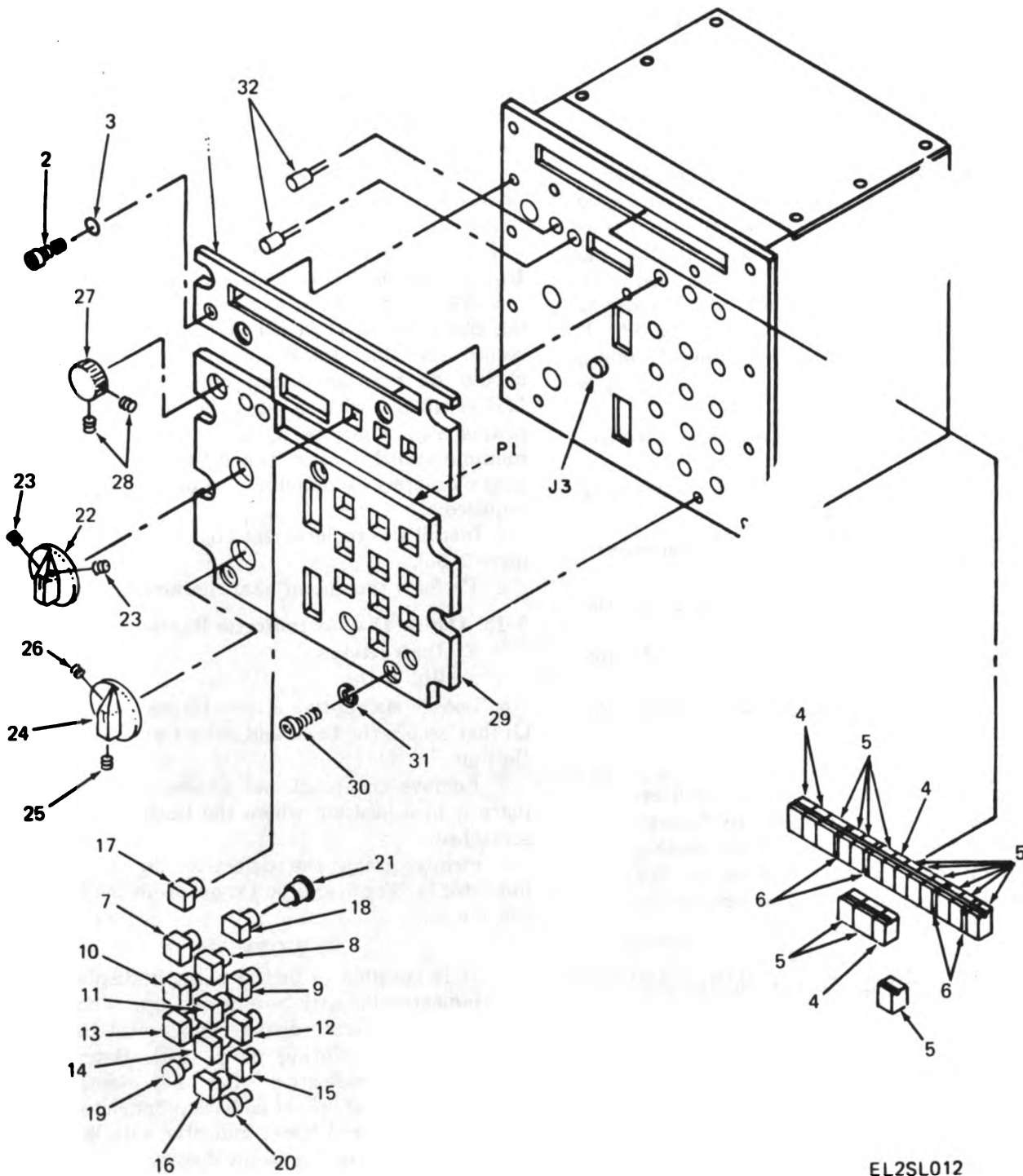
NOTE

It is possible to install numeric display indicator (5) with wrong end up, which causes incorrect display (horizontal bar will appear during lamp test). Before inserting indicator, find key (small depression) at corner on back of indicator, figure 5-2, and insert indicator with key at left upper corner facing display.

d. Replace the digital display indicator by pressing the indicator into the socket where the defective indicator was previously removed.

e. Replace the bezel and gasket assembly and tighten the six captive screws.

f. Perform the operational checkout (para 5-6).



EL2SL012

Fig. Computer-Display Unit, Exploded View.

Change 2

Legend for figure 5-1:

1. Bezel and gasket assembly
2. Captive screw
3. Lockwasher
4. Display indicator (alpha)
5. Display indicator (numeric)
6. Display indicator (decimal/degree)
7. Switch actuating lens
8. Switch actuating lens
9. Switch actuating lens
10. Switch actuating lens
11. Switch actuating lens
12. Switch actuating lens
13. Switch actuating lens
14. Switch actuating lens
15. Switch actuating lens
16. Switch actuating lens
17. Switch actuating lens
18. Switch actuating lens
19. Switch actuating lens
20. Switch actuating lens
21. Incandescent lamp
22. DISPLAY knob
23. Setscrew
24. MODE knob
25. Setscrew
26. Setscrew
27. DIM knob
28. Setscrew
29. Light transmitting indicating panel
30. Phillips screw
31. Lockwasher
32. Incandescent lamp

5-14. Keyboard Switch Actuating Lens Lamp Replacement Instructions (fig. 5-1)

NOTE

To replace a lamp (21) in a switch actuating lens (7 through 20), removal of the light transmitting indicating panel (29) or bezel (1) is not necessary. Each switch actuating lens has grooved sides so that they may be grasped firmly with fingernails and pulled straight out.

- a. Firmly grasp the switch actuating lens (7 through 20) and pull it out from the front of the light transmitting indicating panel (29).
- b. Remove the defective lamp (21) from the switch actuating lens.
- c. Install the lamp in the switch actuating lens.
- d. Replace the switch actuating lens by pressing the switch into the front of the panel in the same location from which it was previously removed.
- e. Perform the operational checkout (para 5-6).

5-15. MEM or MAL Incandescent Lamp Replacement Instructions (fig. 5-1)

- a. Loosen two setscrews (23) from the DISPLAY

knob (22) and pull the DISPLAY knob from the shaft.

- b. Loosen two setscrews (25 and 26) from the MODE knob (24) and pull the MODE knob from the shaft.

- c. Loosen the two setscrews (28) from the DIM knob (27) and pull the DIM knob from the shaft.

- d. Remove the five Phillips screws (30) and lockwashers (31) that secure the light transmitting indicator panel (29) to the unit.

- e. Carefully pry the light transmitting indicating panel away from the unit; this action disengages connector P1 at the rear of the panel from connector J3 of the unit.

- f. Remove the yellow cap from the MEM or MAL incandescent lamp (32), and remove the defective lamp from the front of the unit.

- g. Install the lamp into the MEM or MAL lamp socket and replace the yellow cap.

- h. Place the light transmitting indicating panel (29) on the front of the unit. Carefully press the panel so that panel connector P1 engages with connector J3 on the front of the unit.

- i. Secure the light transmitting indicating panel to the unit; use five Phillips screws (30) and lockwashers (31).

- j. Install the DIM knob (27) on the shaft and tighten both setscrews (28).

- k. Install the MODE knob (24) on the shaft and tighten both setscrews (25, 26).

- l. Install the DISPLAY knob (22) on the shaft and tighten both setscrews (23).

- m. Verify the navigation set operation by performing the operational checkout (para 5-6).

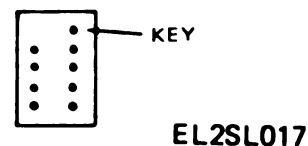


Figure 5-2. Location of Key on Numeric Display.

5-16. Battery Replacement Instruction (fig. 1-3)

- a. Loosen two captive screws on battery cover and pull cover with battery out of CDU.
- b. Disconnect snap fastener terminals from battery and remove battery from cover.
- c. Install new battery in cover and connect snap fasteners terminals to battery, making sure that terminals are fully seated.
- d. Place cover and battery on CDU and tighten two captive screws.
- e. Perform the operational checkout (para 5-6).

APPENDIX A

REFERENCES

- | | |
|---------------------------|---|
| DA Pam 310-4 | Index of Technical Publications: Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders. |
| DA Pam 310-7 | US Army Equipment Index of Modification Work Orders. |
| SB 11-573 | Painting and Preservation Supplies Available for Field Use for Electronics Command Equipment. |
| SB 11-643 | Return Procedures Under Reliability Improvement Warranty (RIW) for Navigation Sets, Doppler AN/ASN-128. |
| TB 43-0118 | Field Instructions for Painting and Preserving Electronics Command Equipment Including Camouflage Pattern Painting of Electrical Equipment Shelters. |
| TM 11-5841-281-20P | Organizational Maintenance Repair Parts and Special Tools Lists for AN/ASN-128. |
| TM 38-750 | The Army Maintenance Management System (TAMMS). |
| TM 740-90-1 | Administrative Storage of Equipment. |
| TM 750-244-2 | Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command), |

APPENDIX B

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

B-1. General

This appendix provides a summary of the maintenance operations for Doppler Navigation Set AN/ASN-128. It authorizes categories of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

B-2. Maintenance Function

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and to detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition; i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting a serviceable

like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance services (inspect, test, service, adjust, align, calibrate, replace) or other maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or resurfacing) to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipments/components.

B-3. Column Entries

a. Column 1, Group Number. Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly. Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions. Column 3 lists the functions to be performed on the item listed in column 2. When items are listed without maintenance functions, it is solely for purpose of having the group numbers in the MAC and RPSTL coincide.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a "work time" figure in the appropriate subcolumn (s), the lowest level of

maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "work time" figures will be shown for each category. The number of task-hours specified by the "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. Subcolumns of column 4 are as follows:

- C—Operator/Crew
- O—Organizational
- F—Direct Support
- H—General Support
- D—Depot

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks. Column 6 contains an alphabetic code which leads to the remark in section

IV, Remarks, which is pertinent to the item opposite the particular code.

B-4. Tool and Test Equipment Requirements (Sect. III).

a. Tool or Test Equipment Reference Code. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool or test equipment for the maintenance functions.

b. Maintenance Category. The codes in this column indicate the maintenance category allocated the tool or test equipment.

c. Nomenclature. This column lists the noun name and nomenclature of the tools and test equipment required to perform the maintenance functions.

d. National/NATO Stock Number. This column lists the National/NATO stock number of the specific tool or test equipment.

e. Tool Number. This column lists the manufacturer's part number of the tool followed by the Federal Supply Code for manufacturers (5-digit) in parentheses.

B-5. Remarks (Sec IV)

a. Reference Code. This code refers to the appropriate item in section II, column 6.

b. Remarks. This column provides the required explanatory information necessary to clarify items appearing in section II.

**SECTION II MAINTENANCE ALLOCATION CHART
FOR
DOPPLER NAVIGATION SET AN/ASN-126**

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT.	(6) REMARKS
			C	O	F	H	D		
00	Navigation Set, Doppler AN/ASN-126	Inspect		0.1				1	A
		Test		0.1					B
		Repair		0.1					
01	Computer Display Unit CP-1252/ASN-126	Inspect		0.1				1	A
		Test		0.1					
		Replace Repair		0.1					
02	Converter, Radar Signal Data CV-3336/ASN-126	Inspect		0.1				1	A
		Test		0.1					
		Replace Repair		0.1					
03	Receiver Transmitter Antenna, Radar RT-1191/ASN-126	Inspect		0.1				1	A
		Test		0.1					
		Replace Repair		0.2					

SECTION III TOOL AND TEST EQUIPMENT REQUIREMENTS
FOR
DOPPLER NAVIGATION SET AN/ASN-128

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	0	Tool Kit, TK-101/G	5180-00-064-5178	

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	Test utilizing the built in test.
B	Repair is limited to removal and replacement of defective knobs, lamps, battery or LRU.
C	All repairs will be accomplished by the manufacturer under the terms of a 4 year reliability warranty.

B-5/(B-6 blank)

GLOSSARY

BRG—	Bearing	RTA—	Receiver-Transmitter-Antenna
BITE—	Built-in Test equipment	SDC—	Signal Data Converter
CDU—	Computer-Display Unit	SP—	Speed
CLR—	Clear	SPH—	<i>Spheroid</i> . Code used during data entry in UTM.
DEST—	Destination	STR—	Store
DIR—	Direction	TAS—	True air speed
DISP—	Display	TGT—	Target
DIST—	Distance	TK—	Track
ENT—	Enter	TKE—	<i>Track angle error</i> . The angle between the aircraft true heading (which is the angle from true north to the longitudinal axis of the aircraft), and the actual path of the aircraft over the surface of the earth relative to true north.
GS—	Groundspeed. Speed of the aircraft over the ground.	UTM—	<i>Universal Transverse Mercator</i> . A military grid reference system used to establish a common reference system between aircraft and ground forces.
HDG—	Heading	VAR—	<i>Magnetic variation</i> .
KYBD—	Keyboard	XTK—	<i>Cross track distance error</i> . Shortest distance between aircraft present position and the desired course line.
LAT—	Latitude		
LONG—	Longitude		
MAL—	Malfunction		
MEM—	Memory		
PP—	Present position		
RAM—	Random access memory. Changeable portion of computer memory that is used to store mission data.		
ROM—	Read only memory. Permanently programed portion of computer memory.		

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General, United States Army
Chief of Staff

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PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.
2-25	2-28		
3-10	3-3		3-1
5-6	5-8		
		FO3	

Recommend that the installation antenna alignment procedure be changed throughout to specify a 2° IFF antenna lag rather than 1°.

REASON: Experience has shown that with only a 1° lag, the antenna servo system is too sensitive to wind gusting in excess of 15 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2° without degradation of operation.

Item 5, Function column. Change "2 db" to "3db."

REASON: The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.

Add new step f.1 to read, "Replace cover plate removed in step e.1, above."

REASON: To replace the cover plate.

Zone C 3. On J1-2, change "+24 VDC to "+5 VDC."

REASON: This is the output line of the 5 VDC power supply. + 24 VDC is the input voltage.

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