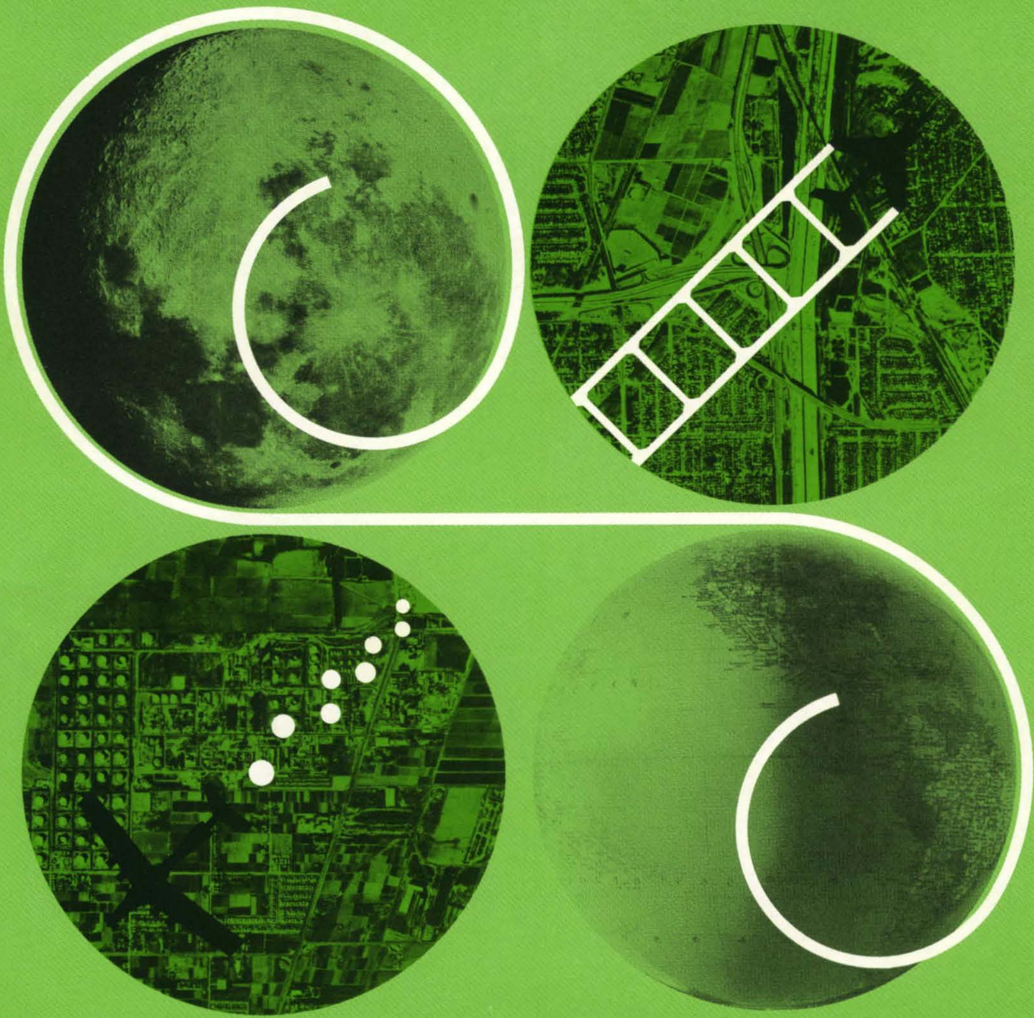
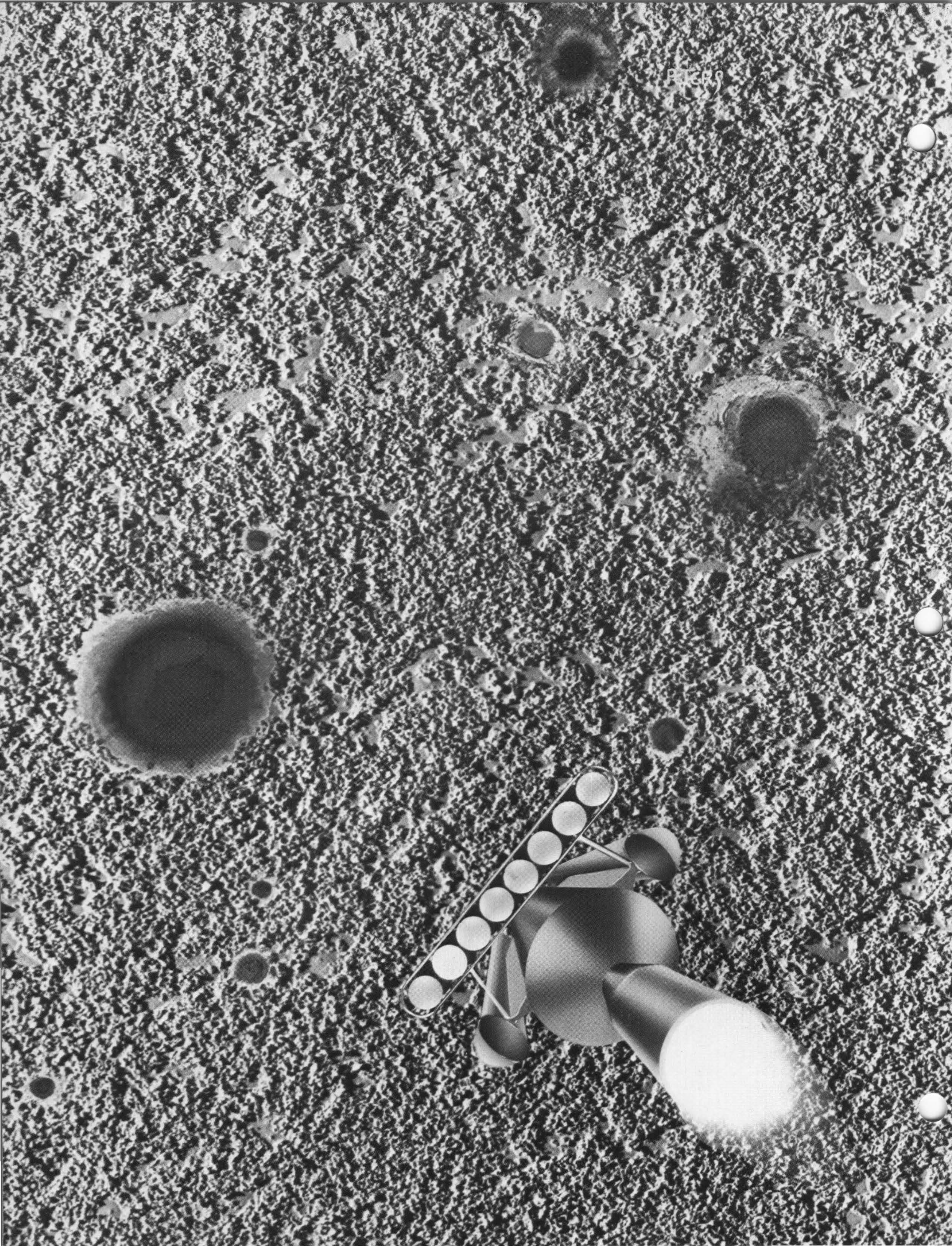
C64—0767

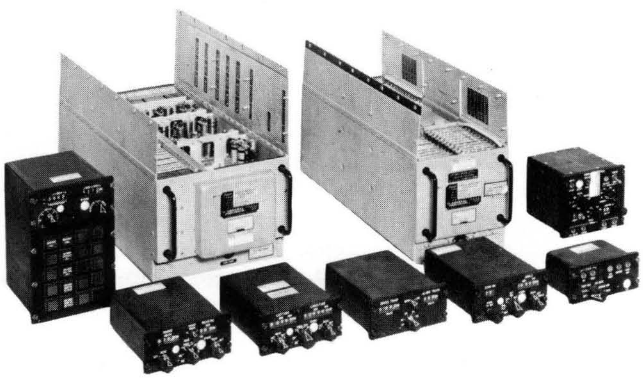
KEARFOTT AN/ASN-24 COMPUTER SETS | TECHNICAL SUMMARY



KEARFOTT PRODUCTS DIVISION • GENERAL PRECISION SYSTEMS INC. • KEARFOTT GROUP • LITTLE FALLS, NEW JERSEY



INTRODUCTION



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The AN/ASN-24 (G) general-purpose digital computer is the natural follow-on to its highly successful forerunner, the AN/ASN-24 (V) which, by early 1966, had logged more than 30,000 hours of flight operating time aboard the Air Force transport giant — the C-141 aircraft.

The AN/ASN-24 (G), designed and fabricated at the Kearfott Products Division's San Marcos, California facility, represents a major improvement in performance while retaining commonality with existing AN/ASN-24 (V) inventory. The AN/ASN-24 (V) has been updated, improved, and value-engineered to result in this new configuration.

The major changes are in a 50% increase in memory capacity and clock rate. Based on these improvements, it has the expanded capability to meet the demands of airborne navigation, flight management, and airborne data processing required in today's ever changing technology. This new system was developed based on the extensive testing and flight experience of the AN/ASN-24 (V) in many different aircraft, in every latitude, and with hundreds of operators.

The AN/ASN-24 (V) has been in active service in the MAC C-141 aircraft flying global routes. Every component has been exposed to the most rigorous laboratory and operational testing. Suggestions for improvements have been collated and carefully scrutinized by our engineers. They have studied and evaluated findings and comments from maintenance and operational military personnel, technicians, engineers, officers, and others intimately associated with the use of the equipment. As a result, Kearfott has designed and is testing the AN/ASN-24 (G) computer set. It has been designed to fit the same mounting racks, to use the test equipment, handbooks, and maintenance procedures, and the same production assembly lines and equipment that are used for the AN/ASN-24 (V).

This brochure briefly discusses principal applications, technical details and specifications of each unit, and supporting data on programming, automatic ground checkout, maintenance, reliability, etc.

The AN/ASN-24 (G) Computer Set consists of — • General-purpose digital computer • Console-mounted control and display units • Input-output equipment, signal conditioners, and power supplies.

In operation, the AN/ASN-24 (G) accepts multiple, varied inputs, processes the data logically and systematically, and almost instantaneously. The resulting computed output data is simple and straightforward — whether as signals to automatic controls or as data the operator can easily interpret and use.

Centralized digital computation holds the key to the many advantages inherent in the AN/ASN-24 (G). During every second of operation, the general-purpose computer carries out thousands of arithmetic calculations, decisions, and commands. Numerous self-checking features virtually guarantee the validity of its operations and solutions. And because it is organized as a general-purpose (rather than special-purpose) computer, it has flexibility to accommodate changes in computation or growth. The program may be altered simply through use of standardized ground support equipment. Possible applications for this versatile computer extend far beyond those discussed here. Inquiries for further specific information are welcome and will bring our immediate response.

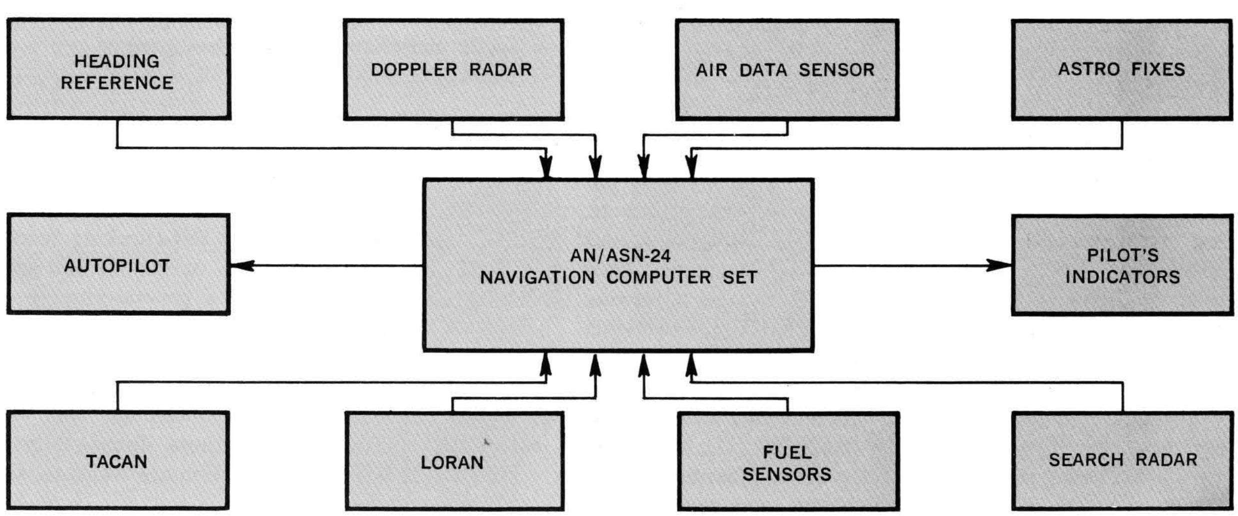
CURRENT APPLICATIONS FOR AN/ASN-24 COMPUTERS

The AN/ASN-24 (V) Computer Set is a general-purpose airborne digital computer system that performs complex, real-time computation and control functions suitable for many aerospace applications. This equipment is being produced at Kearfott's San Marcos facility under Air Force contracts AF33 (616) 5128 and AF33 (616) 6659. The development effort was sponsored by the Aeronautical Systems Division of the Air Force Systems Command. At present, these systems are being produced for the C-141A under AF33 (657) 9023 and other contracts.

Over 200 AN/ASN-24 (V) Computer Sets have been produced and delivered by Kearfott for use in the Military Aircraft Command's (MAC) latest logistic transport, the Lockheed-built C-141 turbofan Starlifter. A large number of these aircraft are now operational providing the United States with a logistic support capability never before possible.

The high speeds at which modern aircraft move make it almost impossible for navigators to interpolate, correlate, and calculate the necessary mass data fast enough and accurately enough to met today's flight requirements. The AN/ASN-24 (V), integrated with a battery of standard sensors, solves this problem: it automatically accepts, processes, and displays a variety of data (in real time), eliminating nearly all the time-consuming routine of former methods.

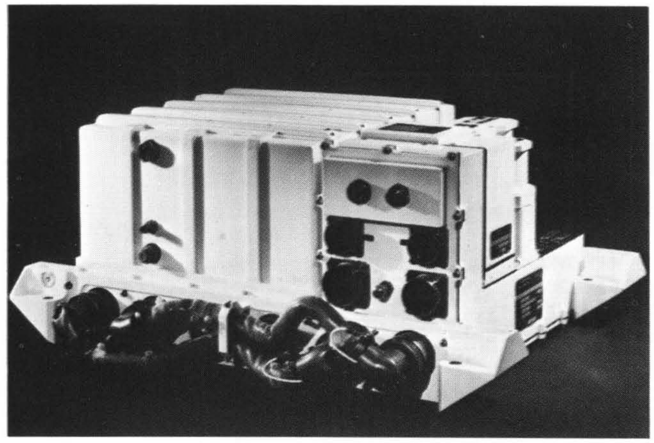
In the C-141A application, the AN/ASN-24 (V) accurately computes and displays aircraft position based on true heading data and inputs from a central air data computer, Doppler radar, and gyrocompass system. In addition, it uses TACAN, LORAN, and navigation radar inputs to update aircraft position. Besides providing outputs of steering commands to the pilot and the autopilot, the AN/ASN-24 (V) constantly furnishes the navigator with such flight information as range-to-go and true bearing to selected destinations, wind, ground speed and ground track, present position unrestricted in latitude and longitude, and along-track/cross-track deviations from the selected flight path. C141A navigation systems can also perform air-drop computations and vertical navigation computations for precision climb and descent maneuvers.



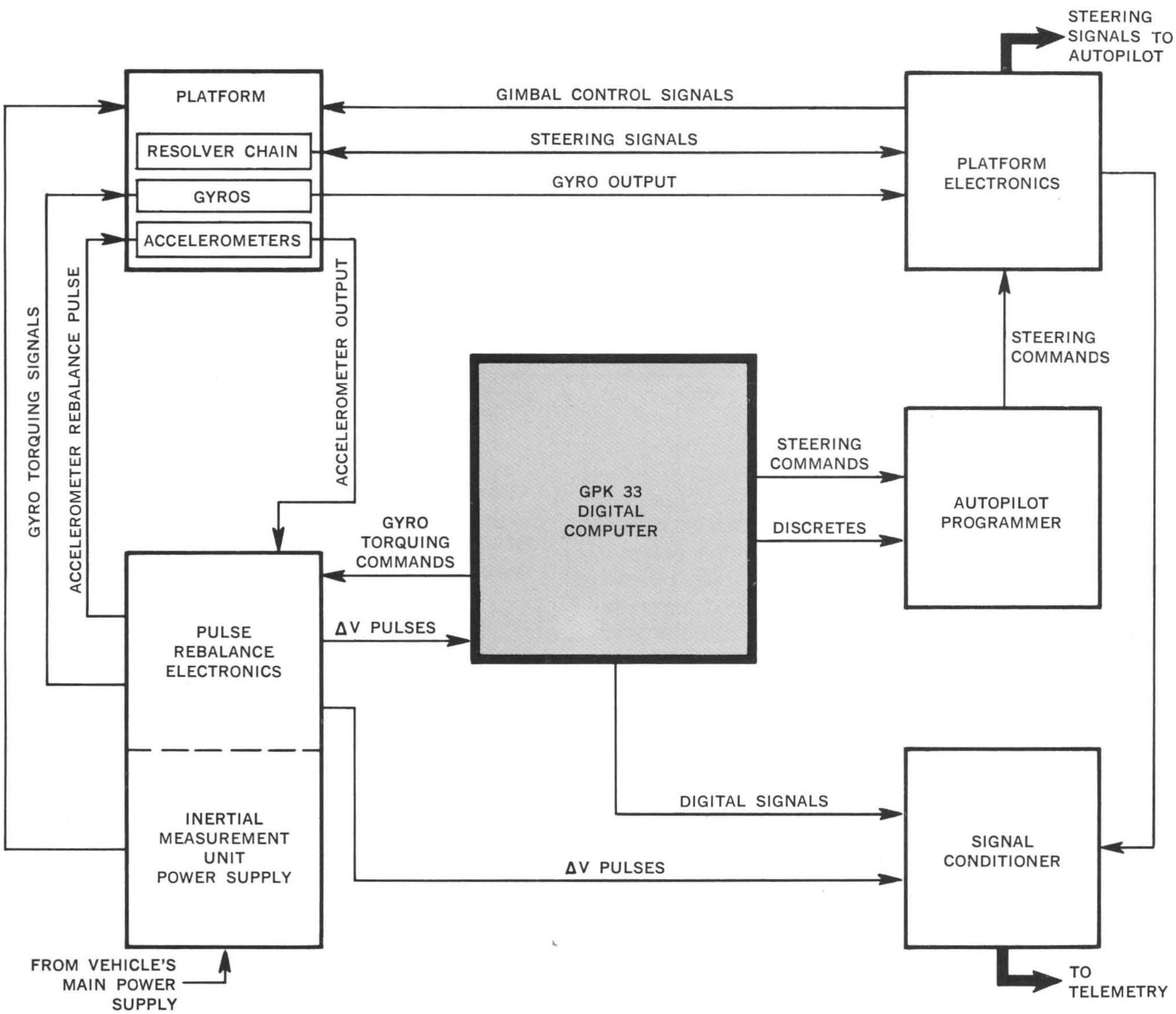
GPK-33 CENTAUR GUIDANCE COMPUTER

A modification of the basic AN/ASN-24 digital computer, as part of the Centaur inertial guidance system, performs critical on-board computing and control functions. It was instrumental in the success of the initial Surveyor soft lunar landing in mid-1966. In both earth-orbiting and interplanetary programs, the Centaur guidance system provides (1) vehicle attitude information during launch and subsequent powered phases of flight, (2) initiates engine cutoff commands, and (3) develops steering signals for injecting the Centaur into the required escape orbit.

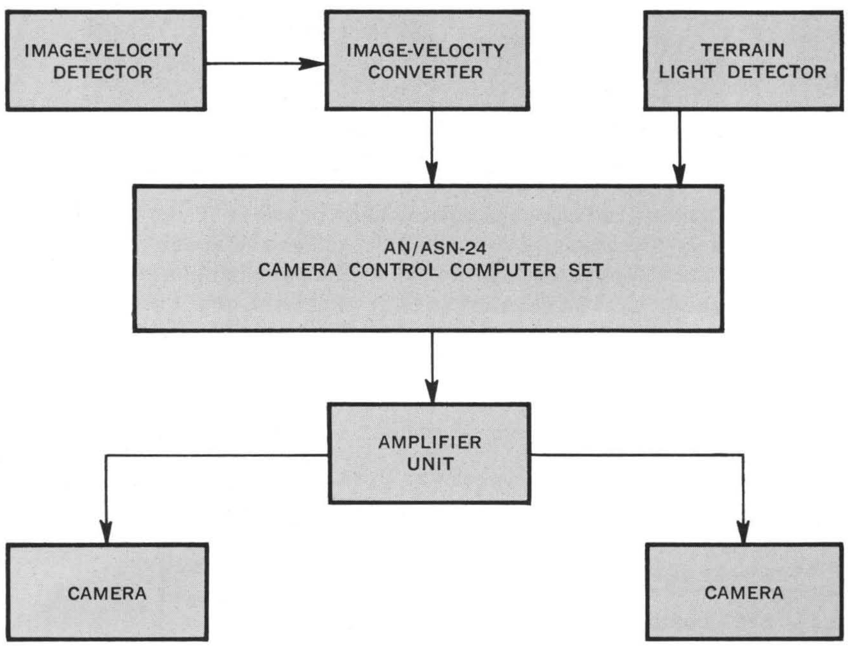
The computer works with a four-gimbal, gyro-stabilized platform which is aligned to an earth-fixed reference before launch and then stabilized to inertial space during flight. Computer inputs are in the form of pulses from the three platform accelerometers and time pulses from a crystal oscillator. These signals are used by the digital computer to calculate vehicle velocity and displacement.



Outputs of this AN/ASN-24 modification are: • Three steering command signals to the guidance autopilot (for roll, pitch, and yaw axes) • Three gyro-torquing signals (for prelaunch platform alignment and for gyro drift compensation during flight) • Discrete output signals (for staging and for initiation and thrust cutoff sequences)



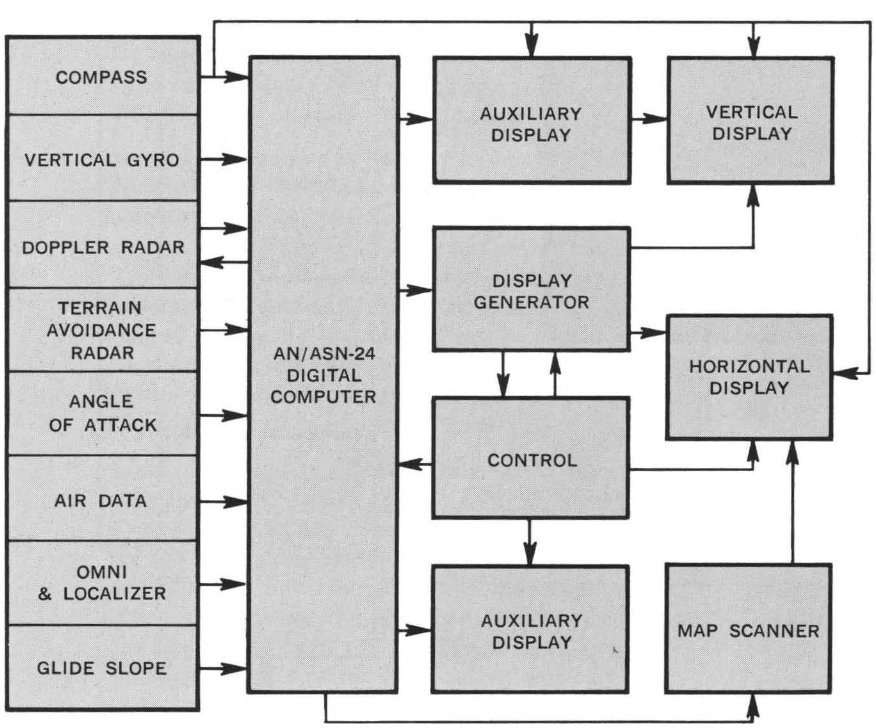
CURRENT APPLICATIONS



DIGITAL CAMERA CONTROL SYSTEM (DCCS)

The high-speed DCCS (Digital Camera Control System) uses an AN/ASN-24 computer to control three basic functions: image-motion compensation, exposure, and cycling rate. System equipment includes, besides the computer, an input-output unit and cockpit-mounted master and station-control units. Among the fixed and variable sensor-data inputs are ground speed, altitude, and amount of reflected light from the terrain below. It adjusts image-motion compensation with extreme accuracy, and it regulates exposure by computing and controlling camera shutter speeds and diaphragm openings. In addition, it adjusts control of cycling rate to provide any required overlap for photos taken in a series. Cycling rate in the DCCS is controlled to an accuracy of 1%.

The DCCS can be operated automatically or semiautomatically and can be adapted to control the most advanced aerial cameras in existence. In extensive preflight evaluation (at the Air Force's space-simulation laboratory of Aeronautical Systems Division, Dayton, Ohio), the DCCS has exceeded specifications.



ADVANCED ARMY AIRCRAFT INSTRUMENTATION SYSTEM (AAAIS)

Under contract from Douglas Aircraft company, a version of the AN/ASN-24 (V) is to serve as the computing center in the unique Advanced Army Aircraft Instrumentation System (AAAIS). This system is designed for installation in Army fixed and rotary-wing aircraft and utilizes navigation sensor inputs and several output displays including two TV-like screens.

The AN/ASN-24 (V) computer drives the system's key displays: two cathode ray tube indicators that present continuous pictorial representations of the vertical and horizontal situations. The vertical display presents the pilot with information on attitude, director flight path, and speed. The horizontal display is primarily a running navigational plot of the aircraft's track over the terrain. The map-type displays can be regulated by selection to scalings of 1:1,000,000, 1:250,000, or 1:50,000.

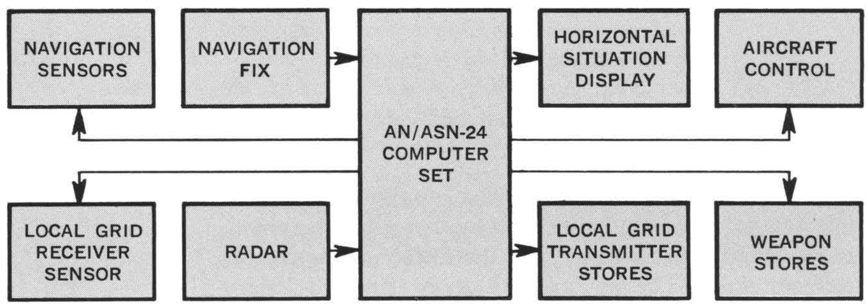
Data processing and computations for the entire AAAIS are performed by the AN/-ASN-24 (V) digital computer. These functions include the following: • Vertical display symbol displacement commands • Horizontal display symbol displacement commands • Navigation computations • Fuel management computations

PROJECTED APPLICATIONS

The following brief descriptions illustrate only three of the many potential system applications for which the versatile AN/ASN-24 (G) Computer Set is well-suited.

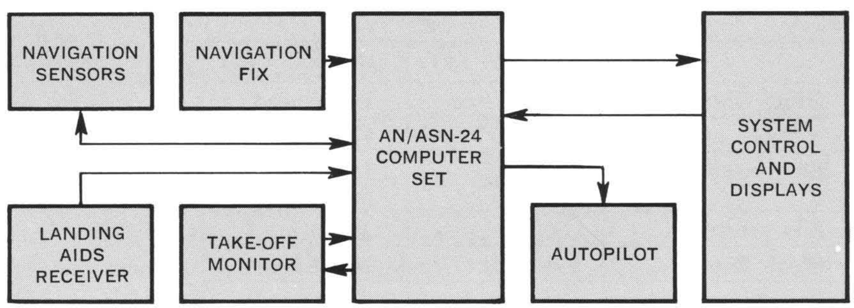
ATTACK WEAPONS CONTROL SYSTEM

The AN/ASN-24 (G) could be effectively used in an avionics system for attack weapons control. Characteristic of the system is its ability to fix a local navigational frame of reference in the attack area. In some cases, the "tracking sensor" can lock onto either fixed objects or the target proper. Here the AN/ASN-24 (G) performs three precision-control functions: (1) conventional navigation to and from the attack area, (2) local grid attack area navigation, and (3) weapons delivery.



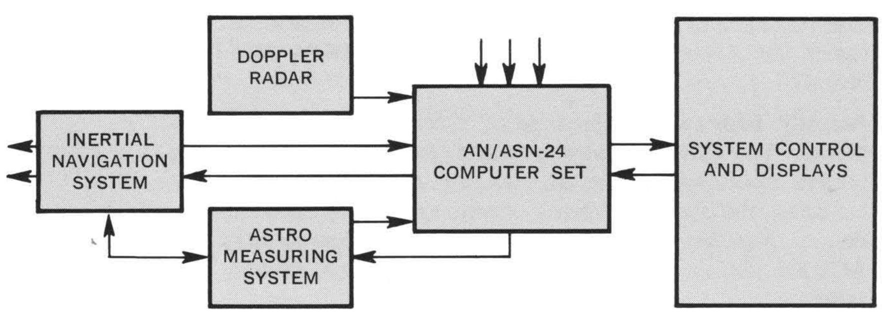
VTOL/STOL AIRCRAFT NAVIGATION/CONTROL SYSTEM

In this proposed role, the AN/ASN-24 (G) could not only execute general-purpose navigation functions but it could also maintain tight, precise control over vertical take-off and landing maneuvers. The pilot would select maneuvers from a variety of programmed profiles, and the computer would then feed both horizontal and vertical data into the autopilot. The system is suitable for helicopter control and for the servicing of high-performance aircraft systems.

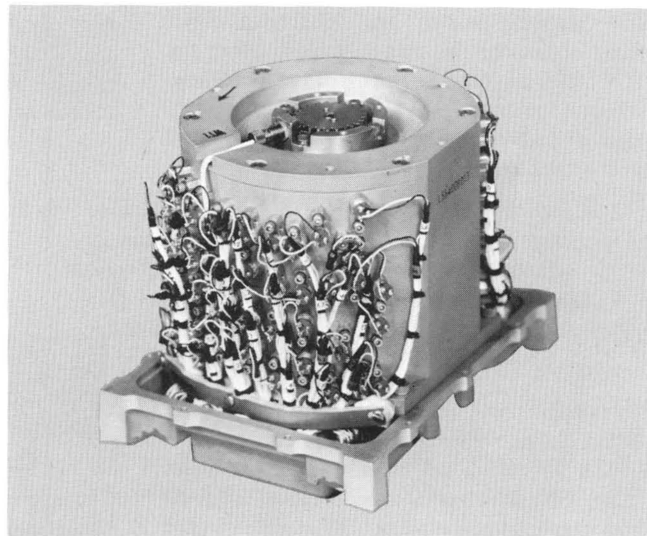


ASTRO-INERTIAL DIGITAL DOPPLER SYSTEM

Used at full capacity, this high-precision system could accurately define aircraft position anywhere in the world and for unlimited periods. It could be applied in virtually all possible missions in any type of aircraft. The light weight, simple AIDDS would consist of presently available, fully proved units combined to employ the strongest, most accurate features of each equipment.

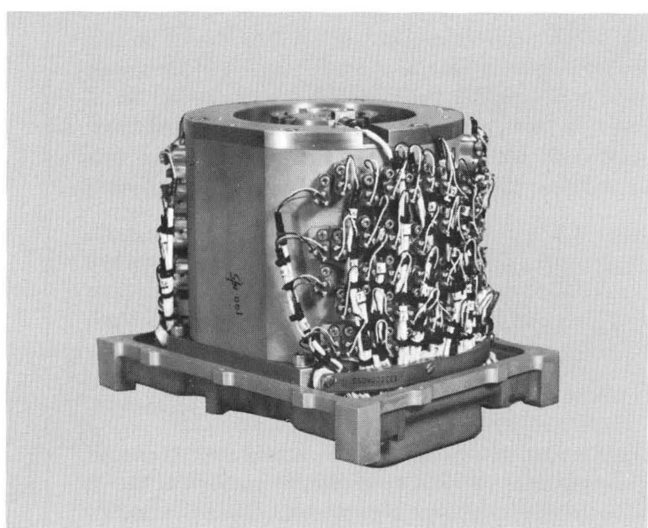


The 50 percent improvement in the capacity and speed of the AN/ASN-24 (G) is obtained by increasing the density of the binary digits packed upon the surface of the rotating memory drum. The new memory drum (Kearfott designation GPK-50) will be physically interchangeable, but the bits will be spaced 50 percent closer together.



Note the following comparison:

	AN/ASN-24 (V)	AN/ASN-24 (G)
Drum Speed	100 rev/sec	Unchanged
Number of Tracks	70	Unchanged
Bit density	113.2 bits per inch	169.8 bits per inch
Bits per track	1600	2400
Clock Rate	160 KHz	240 KHz
Permanent Storage	3840 words	5760 words
Temporary Storage	200 words	296 words
Sigmator	32 words	48 words
Total Storage	4072 words	6104 words



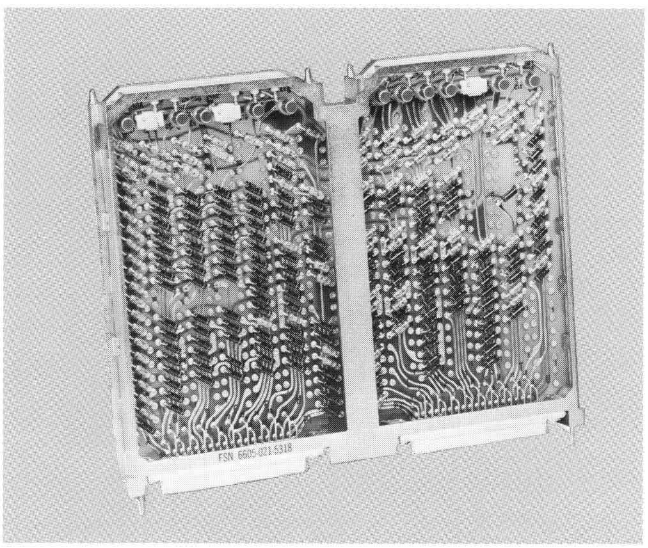
DRUM CHANGES

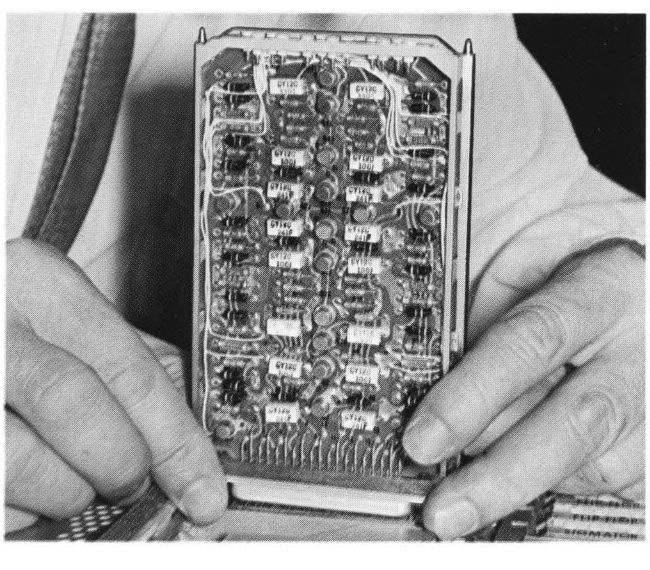
The photographs indicate that there is little difference between the AN/ASN-24 (V) and the AN/ASN-24 (G) drums.

Actually, both are manufactured by exactly the same techniques. The only difference is in the bit density. All important aspects concerning the drum will remain unchanged including the weight, balance, drum speed, and general design. Also, the extensive program of qualification testing, AGREE testing, and reliability investigations will remain valid.

CIRCUITRY MODIFICATIONS

Since the speed of the AN/ASN-24 (G) has been increased by 50 percent, the time available to interpret a signal from a read head, or to impress a signal from a write head upon the drum, has decreased correspondingly. Extensive testing has proven that the logic as originally designed, without changes, is fully able to cope with this situation and retain a wide margin of safety. In other cases, minor components (resistors, capacitors, etc.) have been changed to meet the demands for different time constants, response characteristics, and signal levels. A high degree of commonality between the AN/ASN-24 (V) and the AN/ASN-24 (G) has, nevertheless, been retained, and logic cards manufactured for the AN/ASN-24 (G) will continue to be compatible with the AN/ASN-24 (V). Compatibility has thus been retained in an upward direction.





PROGRAMMING IMPROVEMENTS

The increased capacity and speed of the AN/ASN-24 (G) provides a greatly expanded scope of capability. This increase is actually greater than 50 percent, since the "housekeeping" parts of the program (such as the start routine, computer test routine, subroutines such as sine and cosine and arctangent computation, and navigation computations (such as along-cross track and range-bearing) will remain the same regardless of the overall length of the program. A continuous effort to improve the AN/ASN-24 (V) program has been carried out at San Marcos, capitalizing on theoretical investigations, operation reports, and user suggestions.

Improvements in almost every routine have been achieved including:

DEAD RECKONING ROUTINE — made more accurate, while decreasing program computation time by more than 50 percent.

TACAN FIX ROUTINE — accuracy and frequency increased.

LORAN FIX ROUTINE — fully converged two-position-line fixes available several times per minute, with optimization to take into account angle of cut of position-lines.

RADAR FIXING — fully tracking radar cross-hairs available, with automatic correction of heading with Doppler available or wind with Doppler invalid.

BEST AVAILABLE TRUE HEADING — continuous checking of compass systems to warn operator of unreliable compass operation. Capability of using magnetic headings in polar latitudes. Full capability of using heading corrections established by celestial, radar, or manual means. Compass averaging maintained when more than one compass in use, with both in magnetically slaved mode. Gyro drift rate automatically computed if a celestial heading check is available.

FIX-MONITORED AZIMUTH — heading corrections available from TACAN, LORAN, or manual fixes.

WIND BETWEEN FIXES — Wind available from fixes even when aircraft is orbiting, provided an aid such as TACAN, LORAN, or radar is available.

POLAR COMPUTATIONS — 50 percent decrease in computation time, with enhanced accuracy.

READOUTS — all readouts updated as fast as the human eye can follow, and up to every 1/100 second if required.

BRIEF FUNCTIONAL DESCRIPTIONS *and technical data relevant to the units which make up the AN/ASN-24 (G) are presented in this section.*

CP-GPK-50/ASN-24 DIGITAL COMPUTER

The versatile CP-GPK-50/ASN-24 Digital Computer of the AN/ASN-24 (G) Computer Set features two stored-program sections which operate concurrently: a general-purpose section which performs the add, subtract, multiply and divide functions; and a 'Sigmator" section for such operations as high-speed integration. Both sections use the same magnetic memory drum for instruction and data storage, and the general-purpose program controls data transfers between them.

Additional data concerning the CP-GPK-50 follows:

MODE OF OPERATION

Serial, synchronous, binary

OPERAND FORMAT

Fixed point, 25 bits (equals 7 decimals), two's complement.

INSTRUCTION FORMAT

One + one address	25 bits
Operation code	3 bits
Operand address	11 bits
Next instruction address	11 bits

MEMORY

Magnetic drum	168,000 bits, 6000 rpm
Permanent storage	60 tracks, 5760 words
Temporary storage	4 tracks, 296 words
Sigmator section	2 tracks
Registers, timing	4 tracks

SPEED

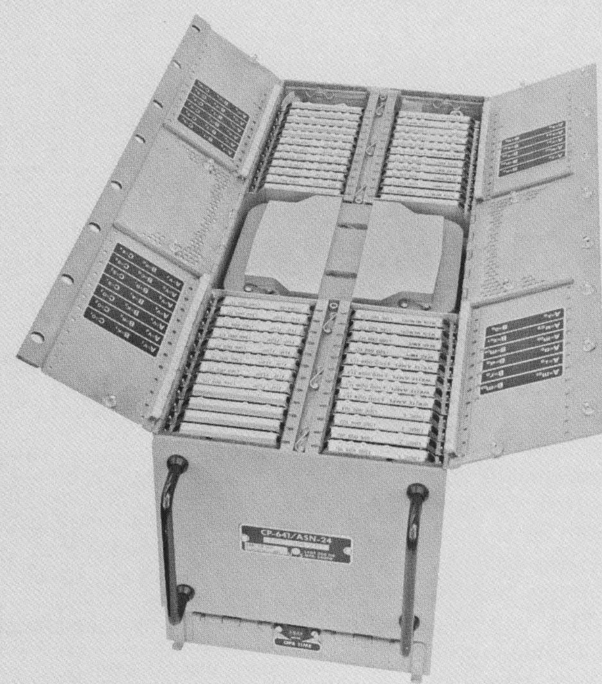
Clock frequency	240 kilohertz/second
Word time	104.17 microseconds

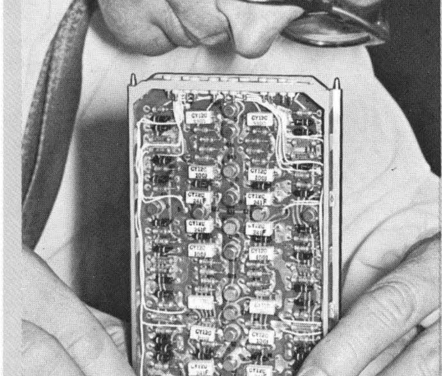
CP-GENERAL PURPOSE SECTION

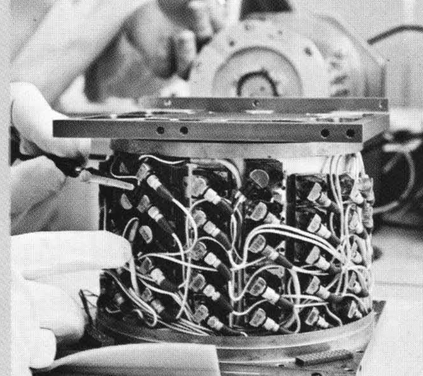
OPERATION	WORD TIMES REQUIRED	INSTRUCTIONS PER SECOND
Clear Add	4	2400
Add	4	2400
Subtract	4	2400
Multiply (m multiplier bits)	4 + m	9600/(4 + m)
Divide (m divisor bits)	5 + m	9600/(5 + m)
Extract (and)	4	2400
Conditional Transfer	2	4800
Store	4	2400
Shift Left m places	4 + m	9600/(4 + m)
Shift Right m places	4 + m	9600/(4 + m)
Clear and Input	4	2400
Extract Input	4	2400

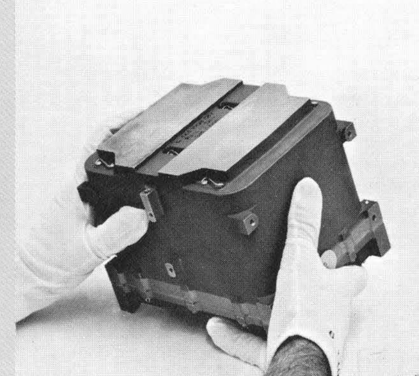
CP-SIGMATOR SECTION

INSTRUCTION	WORD TIMES REQUIRED	INSTRUCTIONS PER SECOND PER VARIABLE
200-Hz Pulse Output	1	200
Accumulate Incremental Input	1	5580
Integrate (real time)	1	180
Integrate (with sign propagation)	1	180
Accumulate Real Time	1	180
800-Hz Data Link	1	800
Input Scanner to Sigmator	1	200
Recirculate	1	200


CP-641/ASN-24







PP-3214/ASN-24 CONVERTER CHASSIS

The PP-3214/ASN-24 Converter Chassis contains equipment for performing computer input-output signal selection, conditioning, conversion and synchronizing. Via these functions, performed under control of the computer, binary data is transferred in and out of the computation center. Inputs from the various sensors and control panels are picked off as shaft angles, pulse trains, continuously changing voltages, on-off signals, and a variety of other forms and fed through input-conversion modules. This unit also converts the computed results, or outputs, into proper forms to drive displays, decimal readouts, telemetry systems, and gyros, and to serve varied other specific needs.

The PP-3214 chassis contains the power supply and associated protective circuitry for the computer set.

The following additional technical data pertains to the PP-3214 unit:

MODULES

Converter modules types A and B, up to 18*
Converter modules types C, D, E, and F, up to 4
Circuit boards (servo amps, etc.) up to 28
Solid-state conversion boards, to 12 bits
Additional capacity . . . Auxiliary converter chassis

* *Types of converter modules vary with the application.*

TYPICAL OPERATIONS

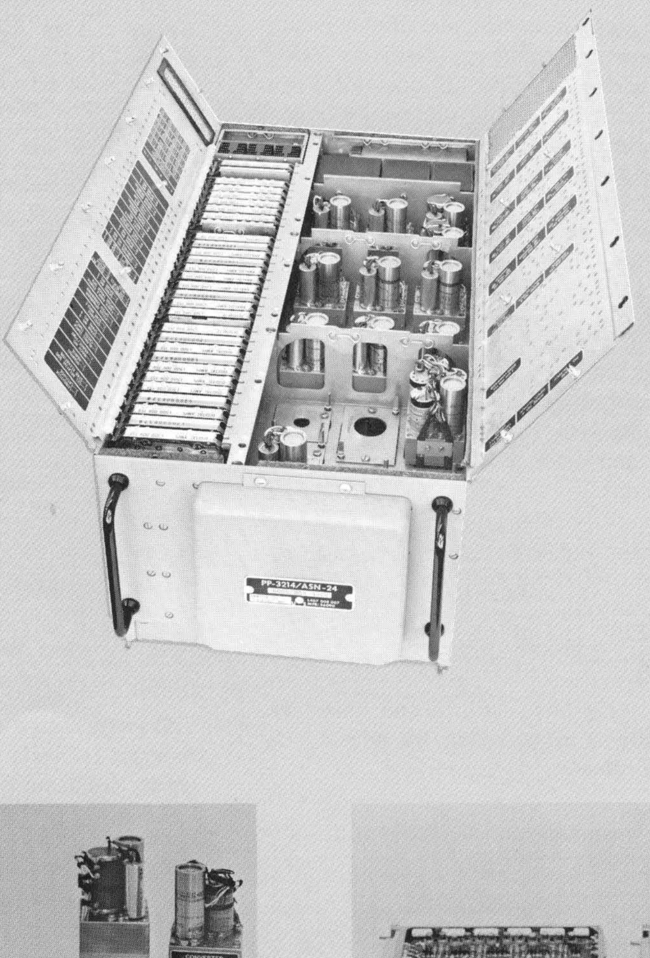
Asynchronous pulse inputs .. up to 4, up to 5.8 kHz each
Parallel encoder inputs .... as required
AC to digital inputs .... as required
DC to digital inputs .... as required
Digital to analog outputs .... as required
Serial outputs .... up to 5.8kHz
Real-time clock .... as required
Discrete controls in, out .... up to 128

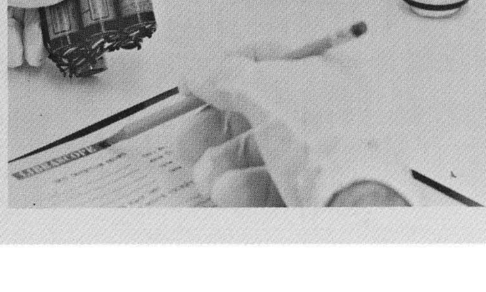
I/O SECTION

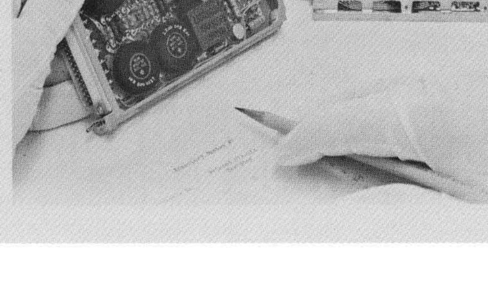
60 unique address selections; up to 17 I/O bits per address. Several functions may be multiplexed under one address when appropriate.

AVAILABLE CONVERTER MODULES

NUMBER	USE	BITS	ANALOG ELEMENT
A1	Input	12	Synchro CT, Size 8
A2	Input	12	Synchro Resolver, Size 8
A3	Input	12	Potentiometer 10-turn, 2k ohms w/adj. potentiometer
B1	Output	11	Synchro CX, Size 8
B2	Output	11	Dual Potentiometer single-turn, 100 ohms each w/adj. potentiometer
B3	Output	11	Dual Potentiometer 10-turn, 6.4k ohms w/adj. potentiometer
B4	Output	11	Dual Potentiometer 10-turn, 4.8k ohms
B5	Output	7	Potentiometer single-turn, 2k ohms
B6	Output	12	Potentiometer 10-turn, 2k ohms
B7	Output	11	Dual Potentiometer 10-turn, 5k ohms, 1.8k ohms
B8	Output	11	Dual Potentiometer sin/cos, 10-turn
B9	Output	11	Dual Potentiometer 10-turn, 2k ohms
C1	Output	13	Four Synchro CX Geneva-geared 1:10:100:1000
D2	I/O	16	Dual Synchro CT 36:1, Size 8, Relay-controlled
E1	I/O	13	Synchro CT Size 11, Relay-controlled
F1	Input	16	Dual Synchro CT 25:1, Size 8
F2	Output	16	Dual Synchro CX 25:1, Size 8


PP-3214/ASN-24


CONVERTER



CONTROL INDICATORS

The representative group of control and display panels described here have self-contained digital-to-analog converters. The panels function, at operator command, to transfer information into the computer and to read out computed data. Any combination of panels can be used at one time. In addition to these human-engineered panels — which are currently available — others can be readily designed and assembled to suit different requirements.

C-3961/ASN-24 CONTROL, COMPUTER SET

Provides computer condition indicators, navigation mode selection, pilot-autopilot selection, destination selection for computations, TACAN station selection, LORAN counter and selector switch for 12 catalogued master stations.

C-3962/ASN-24 CONTROL-INDICATOR, LATITUDE-LONGITUDE

	RANGE	RESOLUTION	SLEWING RATE
Latitude	N90° -S90°	0.165′	100°/min
Longitude	E180° -W180°	0.165′	100°/min

Continuously displays present latitude and longitude. Also permits setting-in of corrected fix, plus up to six destination coordinates.

C-3963/ASN-24 CONTROL-INDICATOR, RANGE-BEARING

	RANGE	RESOLUTION	SLEWING RATE
Range	10,000 1,000 100 mi.	1.22 mi. (high scale)	30,000 mi./min
Bearing	0° -360°	0.176°	2000°/min

Continuously displays range and bearing to any of up to six selected destination points with three scale factors selectable. Also displays wind, ground speed, and track.

C-3965/ASN-24 CONTROL-INDICATOR, CELESTIAL DATA

Used in selecting 64 stars and/or planets with angle display selectable among GHA (Greenwich Hour Angles) of Aries, planets, altitude, altitude intercept, azimuth, true heading, and declination.

	RANGE	RESOLUTION	SLEWING RATE
Angle	0° -360°	0.33′	180°/min

C-3964/ASN-24 CONTROL-INDICATOR, ALONG TRACK/CROSS TRACK

	RANGE	RESOLUTION	SLEWING RATE
Along Track	1000/100 mi.	½ mi. (normal scale)	3000/300 mi./min
Cross Track	100/mi.	0.012 mi. (normal scale)	300/30 mi./min

Continuously displays miles left or right of track and along track to any of up to six selectable destinations, with two selectable scale factors.

CONTROL-INDICATOR, INITIAL ENTRY AND MODE CONTROL (OPTIONAL)

	RANGE	RESOLUTION	SLEWING RATE
Distance	10,000 ft.	1.0 ft	30,000 ft/min
Speed	1000 knots	0.1 knot	30,000 knots/min
Percent	± 100%	0.01%	300%/min
Altitude	100,000 ft.	10.0 ft.	300,000 ft/min
Time	1000 sec	0.1 sec	3000 sec/min
Weight	1,000,000 lb	100 lb	3,000,000 lb/min

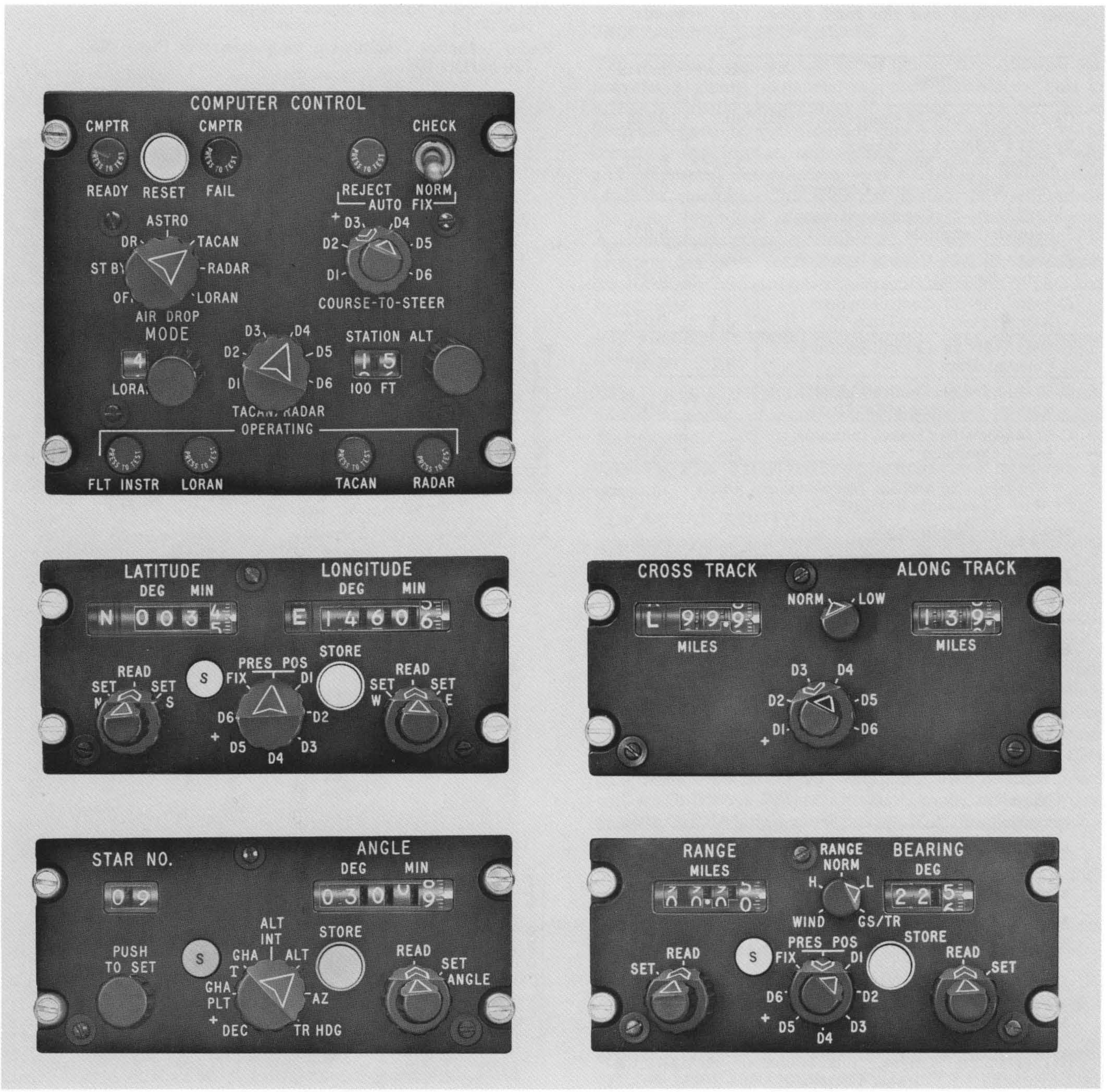
Displays range remaining and maximum altitude. Provides for entry of selected altitude and selection of cruise/climb mode.

DIGITAL/READOUT DISPLAY UNIT (OPTIONAL)

Displays miles of fuel, minutes of fuel, miles to go, and minutes to go. (Panel can be used in many different configurations.)

SOLID-STATE CONVERSION UNITS

Solid-state conversion units are being developed for use in new AN/ASN-24 (G) sets. Featuring up to 13-bit resolution, these units will transform low-level DC analog voltage inputs into binary data. They would replace certain electromechanical elements where such substitution appears desirable. A single unit can be implemented to accept inputs from many different sources selected for conversion by the computer program. Conversion times are on the order of 10 msec with variations producible to accommodate virtually any requirement.


COMPUTER CONTROL
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PHYSICAL SPECIFICATIONS

THE BASIC AN/ASN-24 (G) COMPUTER SET *consists of nine units, but this number is alterable for particular system needs. Because of this flexibility, the specifications tabulated here typify a representative AN/ASN-24 (G) Computer Set, especially in regard to converter chassis weight and the total power requirements.*

UNIT	WEIGHT (LB)	VOLUME* (CU FT)
CP-GPK-50/ASN-24 Computer, Digital	40.3	0.658
PP-3214/ASN-24 Converter Chassis-Power Supply	53.5**	0.910
C-3961/ASN-24 Control, Computer Set	3.9	0.080
C-3962/ASN-24 Control-Indicator, Latitude-Longitude	3.7	0.057
C-3963/ASN-24 Control-Indicator, Range-Bearing	3.4	0.057
C-3964/ASN-24 Control-Indicator, Along-Track/Cross-Track	3.1	0.057
C-3965/ASN-24 Control-Indicator, Celestial Data	3.2	0.057
C-6213/ASN-24 Control-Indicator, Vertical Navigation/Air Drop	2.8	0.057
C-6214/ASN-24 Control-Indicator, Initial Condition	10.8	0.195

* *Not including handles, faceplates, and knobs*
** *With 12 modules installed*

POWER REQUIREMENTS

The following power sources are required to supply the AN/ASN-24 (G):

1. 115 v, 400 Hz, 3Ø, 368w
2. 28 v DC, 33w
3. 5v AC/DC, 6.5w
4. 26v, 400 Hz, 16w

ENVIRONMENT

The AN/ASN-24 (G) is designed for operation within the following range of environmental conditions:

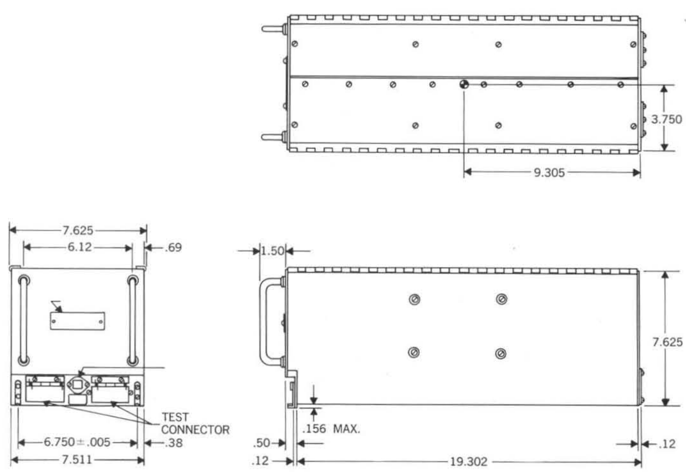
Temperature .... Per MIL-E-5400, Class 2
Altitude .... Sea Level to 70,000 feet
Humidity .... Per MIL-E-5400, Class 2
Shock .... RTCA 120-61/DO-108
Vibration .... Per MIL-E-5400, Class 2
Cooling .... Forced air (ARINC 404)

APPLICABLE DOCUMENTS

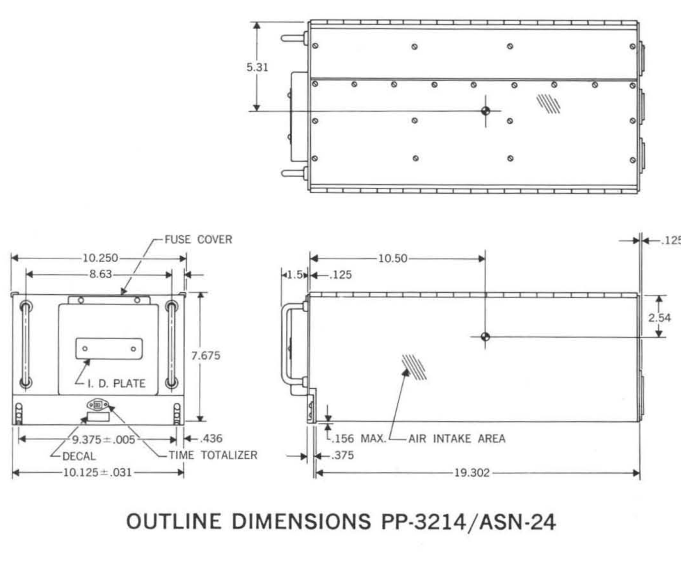
The AN/ASN-24 (G) is designed and manufactured in accordance with the following applicable specifications:

MIL-C-27618	Computer Set, Navigational AN/ASN-24
MIL-C-6781B	Control Panel: Aircraft Equipment, Rack or Console Mounted
MIL-E-5400E	Electronic Equipment, Aircraft, General Specification for
MIL-I-6181D	Interference Control Requirements, Aircraft Equipment
MIL-T-5422E	Testing, Environmental, Aircraft Electronic Equipment
MIL-R-27542	Reliability Program for Systems, Subsystems, and Equipment
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization of
ARINC Spec. No. 404	Air Transport Equipment Cases and Packing
ARINC Spec. No. 407-1	Synchro Signal Practices

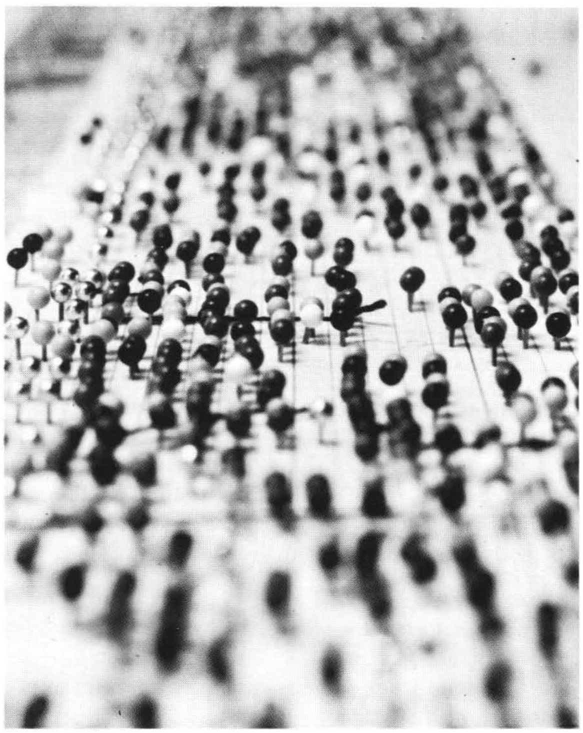
Radio Technical Commission for Aeronautics Paper No. 120-61/DO-108



OUTLINE DIMENSIONS CP-GPK-50/ASN-24



OUTLINE DIMENSIONS PP-3214/ASN-24



AMONG THE MANY superior features of the general-purpose digital computer unit of the AN/ASN-24 (G) is the nature of its programming. With simple techniques, *and without any physical modifications,* the computer can be programmed to perform an exceptionally large variety of functions. And these programs can be quickly altered in the field, when necessary, to account for changes in system hardware, accuracy requirements, or performance parameters.

For each new application of the AN/ASN-24 (G), a new program set is assembled from the existing library of routines. This set is especially tailored to produce the prescribed solutions, with prescribed accuracies, as called for by the system equations. After a program has been composed, tested, and fielded, it will be used frequently. Thus, special care is taken to develop it to a state of high efficiency in terms of both solution rate and utilization of memory space.

Toward that end, the program is first coded into machine language, modified only by use of decimal notation. Automatic encoding procedures transform the program to binary notation for actual operation in the AN/ASN-24 (G). The information is then put into the form of a printed "program book" and a punched paper tape; and finally, through a special Tape Reader/Fill and Verification Unit, the program is recorded from the paper tape onto the computer's magnetic drum memory.

PROGRAM PRODUCTION METHODS

Two major software packages — the AN/ASN-24 (V) Program Assembly System and the AN/ASN-24 (V) Operations Simulation System — are used to assure that new programs are accurately and efficiently prepared. The use of these programming systems minimizes the check-out time and effort spent on actual AN/ASN-24 (G) hardware. It also reduces the possibility of programming conflict with hardware production and delivery.

PROGRAM ASSEMBLY SYSTEM. The Program Assembly System is an automated procedure which (1) decodes the decimal source program into binary notation, (2) prints a "program book" representing the program in terms of logical flow, (3) produces a punched paper tape for loading the computer's magnetic memory drum, and (4) produces a tape for loading the program into a commercial computer for simulation.

OPERATION SIMULATION SYSTEM. The Operation Simulation System executes all AN/ASN-24 (G) computer operations at the register level (arithmetic, memory communications, controls, input/output, etc.) just as they are performed in the AN/ASN-24 (G) itself. Although some operations cannot be precisely simulated, most of the operational program can be checked with this method. The simulation technique effectively trims necessary final check-out time (on the computer set) to a minimum.

PROGRAM ORGANIZATION. The computer program is organized into routines covering functions which are either (1) performed continuously or (2) selected by the operator. Space/time allocations for typical aircraft and missile applications are indicated in the following tables.

PROGRAMMING

SAMPLE PROGRAM ALLOCATION AS USED IN AN/ASN-24 (V) PROGRAM

AIRCRAFT NAVIGATION/ CONTROL FUNCTION	STORAGE (WORDS)	SOLUTION TIME* (SECONDS)
Best Available True Heading	199	0.165
Ground Speed, Track, Wind	117	0.265
Present Position Keeping	128	0.245
Along Track, Cross Track	150	1.40
Magnetic Variation	275	0.095
Astro Navigation	405	0.80
TACAN Navigation	100	0.70
LORAN Navigation	390	2.50
Search Radar Navigation	94	0.60
Control/Display Panel Outputs	252	0.50
Instrument Panel Outputs	47	0.10
Control/Display Panel Inputs	152	0.11
Polar Navigation	128	....
Computer Self-test	34	0.04
Subroutines	412	....
Initialization	127	....

* *Typical computer cycle: 1 to 2 seconds*

SPACE/TIME ALLOCATIONS: TYPICAL MISSILE PROGRAM

MISSILE GUIDANCE/NAVIGATION/ CONTROL FUNCTION	STORAGE (WORDS)	SOLUTION TIME* (SECONDS)
Preflight Inertial Platform Alignment and Calibration	600	0.53
Missile Position	250	0.18
Missile Velocity	150	0.08
Missile Steering Commands	400	0.15
Missile Autopilot Control	215	0.03
Inertial Platform Torquing Commands	100	0.05
Telemetry	150	0.06
Computer Self-Test	35	0.02
Initialization	300	....

* *Typical computer cycle: 0.42 to 0.60 second*

PRODUCT SUPPORT

A comprehensive Product Support program is available to assure complete customer satisfaction. Under guidance of the program director, this operation divides into the following five areas of activity:

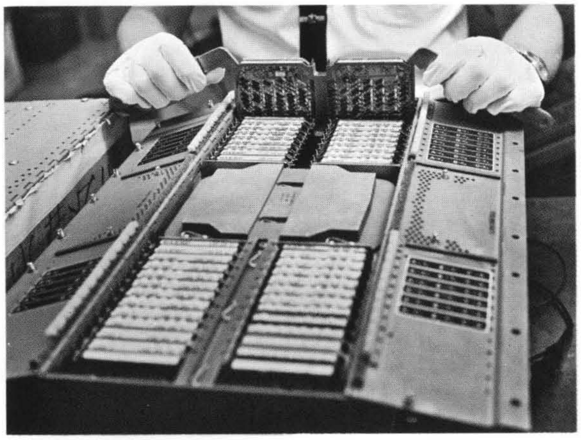
TECHNICAL PUBLICATIONS. Complete documentation is furnished on operational theory and instructions; service, maintenance, and trouble-shooting; repair and replacement of parts; and testing of the AN/ASN-24 (G) Computer Set. This information applies at both field- and depot-maintenance levels.

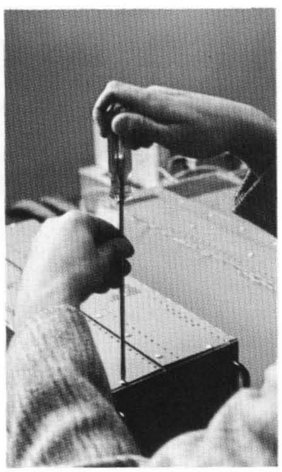
SPARES MANAGEMENT. Experience-dictated spares management begins when the computer set leaves the production line. Realistic provisioning parts breakdowns define the in-service inventories needed for proper support.

REPAIR AND MODIFICATION SERVICE. Performed in the field during testing and changeover of maintenance duties to user personnel, this service results in efficient use of spares and proper follow-on training of user personnel. A similar service is maintained at factory level. Work on customer-owned equipment is separated from normal production activity, and all repair and modifications are made by skilled technicians thoroughly familiar with the particular application.

FIELD-SERVICE ENGINEERING. All field representatives are qualified professional engineers with broad experience in field operation, navigational procedures, and flight-test planning. They have a high order of technical competence and are fully qualified to supervise the implementation of new applications of the equipment.

TECHNICAL TRAINING. An 8-week course, given either at our facilities or at user sites, enables user personnel to become proficient in field operation and maintenance of the AN/ASN-24 (G) Computer Set.





The AN/ASN-24 (G) was designed for exceptionally simple testing, service, and repair. Accurate, uncomplicated test equipment and procedures help to speed check-out and fault isolation. Modular "building-block" construction helps to facilitate the replacement of defective units.

MAINTAINABILITY

The inherent electrical and mechanical features of the AN/ASN-24 (G) guarantee that proper maintenance can be performed at all levels with minimum back-up test equipment, spares, and facilities. The present computer set meets all military and NASA maintainability requirements for levels of support, training, and use of contractor-generated technical orders.

A principal reason for "ease of maintenance" in servicing the AN/ASN-24 (G) is its modular design. Individual plug-in modules contain the electronic building blocks. Circuits are designed so that their digital operation is independent of the sources and the terminations of their information pulses. They are, therefore, completely interchangeable by function, without need for trimming or adjustment after replacement.

Another major maintenance advantage is that the entire set can be tested while installed in the aircraft. Appropriate test modes are activated to solve simulated flight navigation problems and to display the answers in normal fashion, as readouts on the control-indicator panels. Results of test problems are known quantities represented by exact decimal numbers. If a panel registers an incorrect test answer, prescribed testing procedures are used to isolate the faulty black box. Once pinpointed, the defective part is easily replaced by a back-up spare.

Perhaps the best feature of the digital AN/ASN-24 (G) Computer Set is its use of go/no-go test techniques for simple and effective check-out. Unlike analog systems, the AN/ASN-24 (G) does not call for the "experience judgment factor" on the part of maintenance personnel; nor does it require the long down-times necessary for testing, calibration, and adjustment of analog equipments capable of doing a similar job.

MAINTENANCE TEST EQUIPMENT

A comprehensive set of maintenance test equipment was specifically designed and built for the AN/ASN-24 (V). The six testing and servicing units, designed for packaging into easily portable equipment (1) permit complete electrical checkout of computer components, and (2) simulate the interfaces of the combined computer/sensor system, duplicating conditions of operation during flight. This combination of component checkout and interface simulation results in full-range dynamic testing. Other standard equipment is used in test and checkout including oscilloscope, signal generator, multimeter, differential voltmeter, and transistor test set. An economical set of spares completes the field equipment. Typical of sound spares management are the fourteen flip-flop modules in the C-141 configuration. These modules are identical, completely interchangeable, and need no calibration or alignment. A brief description of each major piece of test equipment is given:

COMPUTER TEST STAND. A bench test upon which the computer and converter chassis are connected during test and maintenance. Test point monitoring panels are incorporated into the stand for checking the operating electrical power of the computer.

MAINTENANCE

DYNAMIC TEST SET. Mounts two panels: the Dynamic Test Panel for controlling and monitoring the computer and changing or replacing the permanent program in the main memory; and the Tape Reader and Fill Panel which contains a motorized tape reader unit and tape fill control. These units can read a prepunched paper tape to load an entire computer main memory track (64 words).

DIGITAL TEST SET. Contains circuitry required to test individually all active digital plug-in modules of the computer set. The following networks are tested: clock amplifier, converter select, Doppler amplifier, dual read amplifier, dual write amplifier, main memory preamplifier and headgate, register preamplifier and Sigmator, and triple flip-flop.

LOGIC CARD TEST SET. Enables the operator to individually test the nine modules of the computer.

SERVO TEST SET. Contains power supplies, switching circuits, and indicators to test seven control-indicators, six different types of analog-to-digital converter modules, and four circuit cards from the converter.

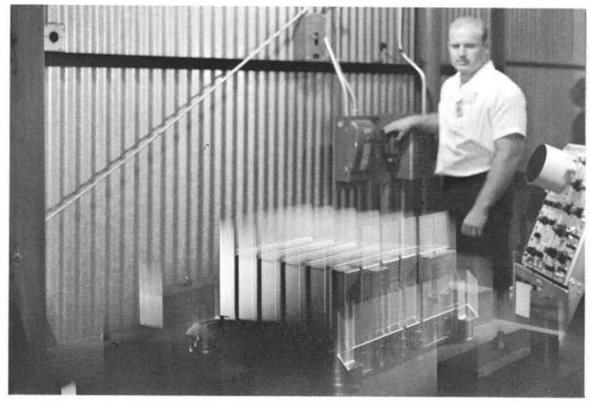
LEVELS OF MAINTENANCE

SQUADRON MAINTENANCE. At this level, malfunctions (if any) are detected and the faulty components are identified during standard preflight tests which check the computer set, its peripheral equipment, and the interconnecting wiring. Additionally, the computer performs its own highly reliable self-test. Because these tests are performed with the computer set in flight-ready condition, a "go" completion guarantees operational status. When necessary, major units can be replaced at squadron level.

FIELD MAINTENANCE. At this level, defective units are checked out on appropriate test equipment. The computer and/or the converter chassis are installed on the Test Stand and connected to the Dynamic Test Set. Prescribed test points are then used to localize malfunctions. This localization is further refined by placing a suspected card on an extender, then checking individual portions of the card. Plug-in units and individual components may be replaced as required at field maintenance level.

DEPOT MAINTENANCE. Replacement and repair not authorized for lower levels of maintenance are accomplished at the depot level. Besides repairing the plug-in units, depot personnel can also alter or rearrange information on the computer's drum memory by using the Fill and Verification Tape Reader. Technicians use the System Simulator Test Set to check all repaired units before returning them to service.

RELIABILITY



Excellent reliability can be expected from the AN/ASN-24 (G) as indicated by the reliability data compiled for the AN/ASN-24 (V). A rigorous documented reliability program was initiated early in the design development phase of the AN/ASN-24 (V) based on the requirements of MIL-R-27542 (USAF) and MIL-STD-441. Demonstration was in accordance with MIL-R-26667. Following the reliability findings, the optimum design for reliability had been established by the time of qualification and freezing of configuration.

DEMONSTRATION TESTING. The computer successfully passed all qualification tests to its own specifications (MIL-C-27618, ASNLS 61-11, and SELS 64-5). It also qualified according to specially strengthened MIL-E-5400 Class 2 requirements. These specifications required demonstration of reliability to MIL-R-26667A requirements at stress level 3. During a 2575-hour demonstration test, only two minor failures (to the CP-641 Computer) occurred, neither of which were attributable to design deficiencies, and both were easily remedied.

OPERATIONAL RELIABILITY. During more than 20,000 hours of actual flight operation, the computer CP-641 exhibited an MTBF of about 1500 hours, based on primary failures which reflect inherent computer reliability.

SUBASSEMBLY RELIABILITY. As further evidence of the achieved reliability of the AN/ASN-24 (G) Computer Set, extensive figures have been compiled for the subassemblies. This detailed data was based on MIL-HDBK-217 and is available at Kearfott.

INTERFACE EQUIPMENT

The AN/ASN-24 Computer Set has already been interfaced with a wide variety of other equipment:

C-131 (7813 WPAFB) — • Kollsman C2A True Airspeed Computer • APN-81 Doppler Radar • Radan 502 Doppler Radar • J2-Compass • J4-Compass • AN/AVN-1 Astronomical Navigation Set • AN/ARN 21 TACAN Set with Coupler (Type 161B1) • B-1 Gyro-Magnetic Heading Reference • ID-526 ARN Bearing Distance Heading Indicator

C-141 — • ARN-21 TACAN Set with Coupler • AN/APN-59B Search Radar • Indicator, Attitude, ARU-2B/A • Computer, Flight Director CPU-65/A • Indicator, Horizontal Situation, AQU-4/A • Computer, Central Air Data CPU-32/A • Doppler Radar Set, AN/APN-157 • (Tentatively) Navigational Set, Astro, AN/AVN-2 • LORAN Navigation Set, AN/APN-151 • Compass System, Gyroscopic, C-12 • (In process) Synchronous Astro Compass • PB-60A Automatic Pilot

DIGITAL CAMERA CONTROL (Equipment designed to operate with following devices, but no flight trials conducted)

• LA-15 Power Supply • E-1 Servo Amplifier • DCCS-LA-17X Amplifier unit • A-9B Camera Magazine • K-17D Camera • DCCS-A-28X Camera Magazine • KA-2 Camera • Terrain Light Detector or Simulator • DCCS-LA-20X Image velocity converter • LA-19 Image Velocity Detector

AAAIS — • ACF Map Scanner • Vertical Gyro • Fuel Flow Rate Sensor • Terrain clearance Radar system • Distance Measuring Equipment • Localizer • SCAT System • LFE Doppler Radar • ADF • Air Data Computer • Auxiliary Altitude Indicator • Engine Tachometer (Spec MIL-G-9398A) • Vertical Rate Counter • Display Generator (DAC DWG 78176655-501)

665A (C-135 AIRCRAFT) — • APN-145 LORAN A-C • AN/AVN-1 (modified) Navigation Set, Astro • AN/APS-73 (XH-2) (Modified) Radar Set • C2 True Airspeed Transducer • AN/ARN-21 TACAN Set with coupler • ELINT Target Receivers • Auxiliary Data Recorder • Reconifax VI Infrared Visual Line Scan Sensor • AN/APN-42A Radar Altimeter • AN/APN-81 (mod) Doppler Radar • NI Gyroscopic Compass • J4 Gyroscopic Compass • Autopilot

CENTAUR — • DYG 8016 Inertial Guidance System, an integral part of the DYG 8012 Missile Guidance System (Honeywell, Inc.) • GDC Telemetry Set (Autopilot)

BACKGROUND

The three major elements of General Precision's Kearfott Group (Kearfott Products, Systems, and GPL Divisions) contribute to the improved performance of almost every military aircraft or vehicle by means of the navigation systems or subsystems they have designed and are producing. This experience dates back almost 25 years.

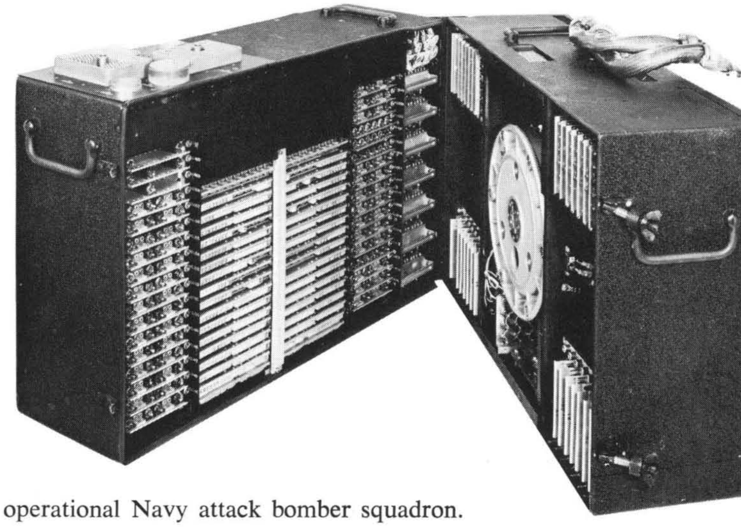
Kearfott, having been initially involved in radio navigation aids in the 30's, has continued to the present time supplying gyros and navigation computers for tactical, strategic, and other aircraft. It has supplied inertial navigators and central gyro reference systems for a variety of military aircraft. GPL, the pioneer in Doppler navigation, continues to provide state-of-the-art Doppler navigators to the military and to commercial aircraft. It is this combination of experience coupled with the technical leadership in digital computers of our personnel in the San Marcos facility that assurance is provided of desired performance and proven capability in the field of airborne computers. Knowledge of the basic navigation problems for almost every vehicle coupled with the experience of years in the design of transducers and their related systems marks this company as one of the truly unique organizations serving the broad aerospace market today.

To support these efforts, a central research center, adequately staffed and equipped, is aiding the producing divisions in basic and applied research related to the specific product interests of the divisions. This facility thus provided the immediate response for technical investigations of problem areas and long-term aid for the development of new products.

General Precision's Kearfott Group now occupies in excess of 1.4 million square feet of floor space in plants located in New Jersey, New York, North Carolina, Ohio, and California. Total employment at the present time is in excess of 7,000. Of this total, 44% are related to manufacture and test, 36% to engineering and other technical functions. The balance is distributed among administration and other functions.

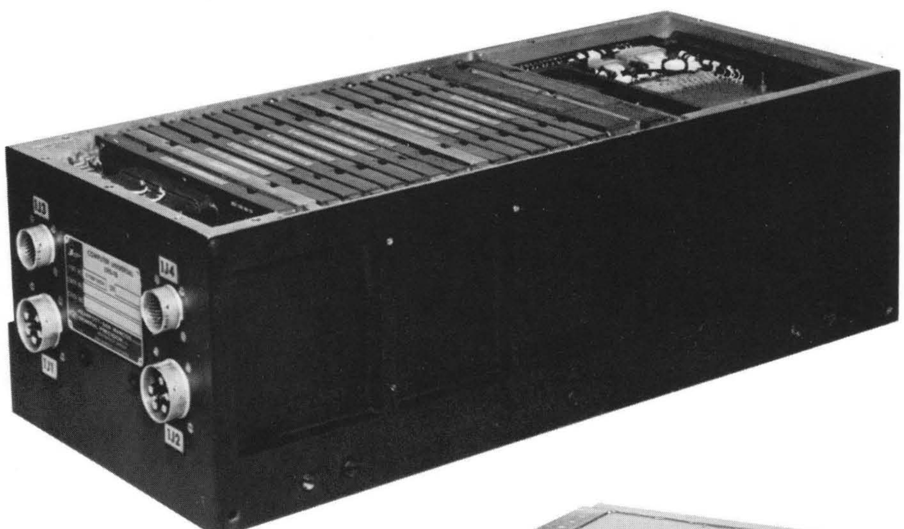
RELATED PRODUCTS

Besides the AN/ASN-24 Computer Sets described in this brochure, the following represent other achievements of the company in the design and production of airborne computers.

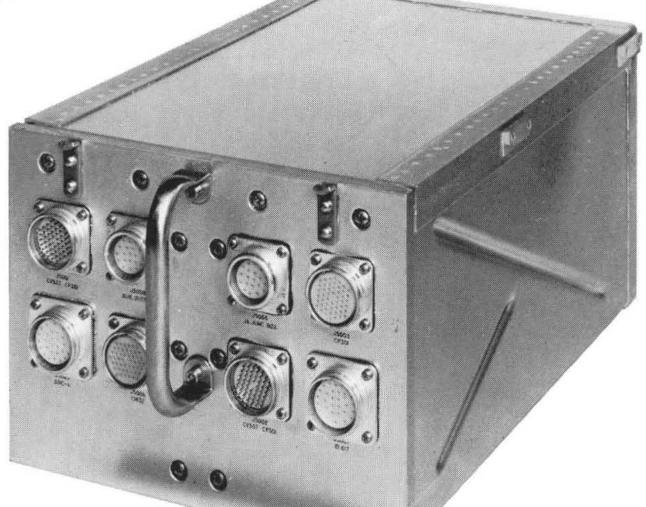


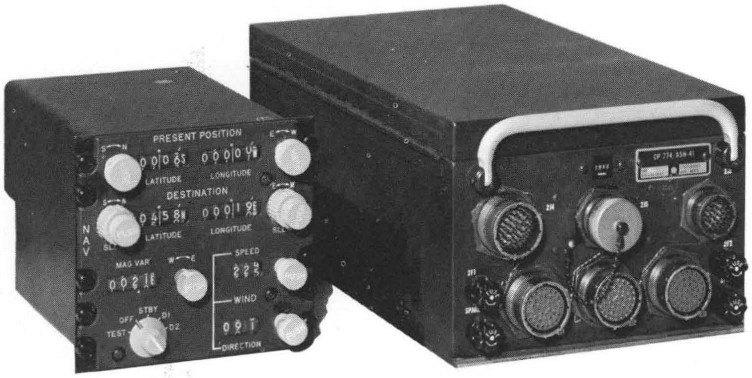
CP209 COMPUTER — first digital device performing bombing and navigation functions in an operational Navy attack bomber squadron.

L90-1 COMPUTER — Using integrated silicon microelectronics, this high-speed, general-purpose computer features serial arithmetic processing at 5 megahertz and random access storage of up to 16,384 words, 28 bits in length.



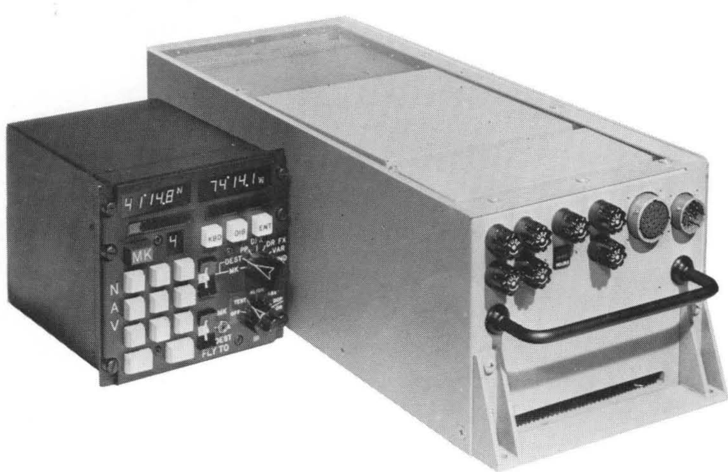
AN/APN 131 COMPUTER — This computer, used in the F105, is the predecessor of the current MINAC series and pioneered many of the advanced concepts incorporated in the later computers designed by the company. Looking to the future, new analog, digital, and hybrid computers are being designed for advanced applications in manned aircraft and space vehicles.



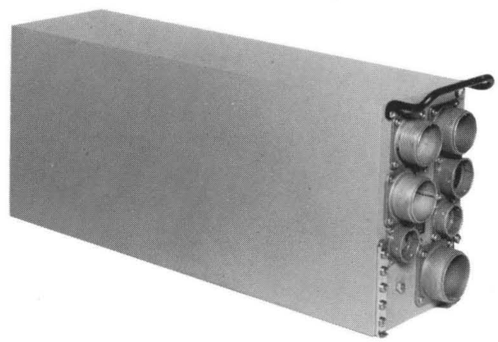


AN/ASN-41 COMPUTER SET — Now operational in the Navy's A4E, built by Douglas, marks the entry of a truly hybrid computer into the military service. It features a high accuracy miniature analog portion to perform the basic trigonometric functions and a digital integrator in the output providing high accuracy, highly reliable position data. This computer accepts Doppler inputs from the GPL AN/APN 153 radar.

MICRO-MINAC COMPUTER — A significant advancement in the development of small, lightweight, low-cost navigational computers, MICRO-MINAC replaces an earlier analog type without disrupting associated system equipment or cabling. Consisting of a programmable solid-state computer element together with a separate MINAC control/display unit, this airborne computer set has a number of desirable capabilities built into it to enhance its use in tactical warfare missions. The computer segment contains synchro-to-digital converters, digital-to-analog converters, a digital processor, and a power supply. It accepts true air speed, drift angle, ground speed, magnetic heading inputs from Doppler radar, a magnetic compass, and an air-speed sensor to provide relative ground track, relative bearing to destination, distance-to-go outputs to a Bearing-Distance-Heading Indicator (BDHI). Doppler-mode-computed present position, wind direction and velocity, together with marked target coordinates are selected by the operator for readout on the computer set's accompanying Control/Display panel. All computer outputs can be made available to other devices.



GPK-10 COMPUTER — A whole-number microelectronic computer for central navigation, guidance, and real-time data processing applications aboard aircraft, missiles, and spacecraft, GPK-10 uses minimal serial logic and a simple, modulary expandable Librascope L207 disc memory whose capacity can be extended by additional head modules. Characterized by a flexible digital interface and simple arithmetic structure, this computer can handle a variety of input/output combinations to satisfy requirements of many applications. Its self-contained power supply incorporates a high-frequency switching regulator contributing to high efficiency and minimal size and weight. Immune to line voltage transients, the power supply includes a standby circuit providing temporary power during voltage transfer or other extreme voltage transients.



GPK-20 COMPUTER — A general-purpose digital computer for navigation and weapons delivery in military aircraft. Has modular random-access solid-state expandable core memory, arithmetic and control sections, A/D conversion, and power supply in a single unit, and incorporates self-protection against memory loss.

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KEARFOTT PRODUCTS DIVISION

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