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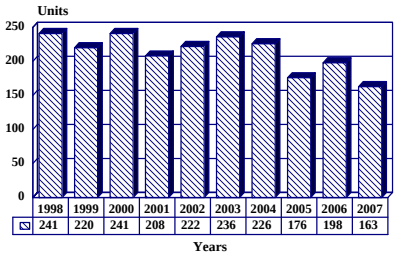
AYK-14(V) - Archived 3/99

Outlook

- This airborne data computer is in production, continuing as the Navy's standard
- AAYK-14 units have been redesignated the Advanced Mission Computer (AMC) which will be installed on all USN/USMC F/A-18E/Fs
- Final three forecast years are US consumption only for F/A-18E/Fs, V-22s, and SH-60R upgrades

10 Year Unit Production Forecast
1998 - 2007



Orientation

Description. Standard airborne data computer.

Sponsor
US Navy
Naval Air Systems Command (NAVAIR)
Washington, DC
USA

Contractors
Ceridian
Computing Devices International
Advanced Systems Division
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(Prime: Production)

Status. In production and in service.

Total Produced. Through 1997, approximately 7,776 systems were produced.

Application. General-purpose digital computer primarily for aircraft applications, but also used in land and sea-based systems.

Price Range. Approximately US$175,000 per unit based on contract averaging (1998 dollars).

Technical Data

Design Specifications. The AYK-14(V) is a variable-configuration, general-purpose 16-bit computer featuring a performance range of up to 2.3 million instructions per second (MIPS). The computer has a high degree of functional and mechanical modularity, and is designed for flexible growth and extensive hardware commonality. The AYK-14(V) architecture is not altered by modular hardware configuration changes, permitting the use of Machine Transferable Support Software (MTASS) systems. This software is compatible with the UYK-20 and UYK-44, permitting the adaptation and use of existing UYK-20 and UYK-44

support software as a development and maintenance tool.

The AYK-14(V) computer system consists of a series of pluggable modules, enclosures, support equipment, and software. The system is composed of functional modules that form the following subsystems: the Processing Subsystem, the Memory Subsystem, the Input/Output Subsystem, the Power Subsystem, and interconnecting data transfer and control buses.

System configurations can range from a 16-bit single card IOP to a 32-bit high-speed processor with extensive input/output abilities. The I/O is expandable to 16 channels total, and is MIL-STD-1553A/B, PROTEUS, and RE 232 compatible. Memory capacity is up to four million words. The 16K or 32K option applies to a number of different areas including memory and instruction.

Operational Characteristics. The AYK-14(V) computer consists of a series of standard computing elements that provide an extremely wide range of applications. A general complement of standard computer module building blocks configurable to specific user needs is made possible by the use of basic shop-replaceable assembly units.

Representative applications include airborne, shipboard, and land-based uses as a general-purpose processor, emulator, controller, dedicated processor or algorithm unit. In that respect, the AYK-14(V) can perform the following tasks: weapons delivery, fire control, guidance, communications, navigation, display subsystem control, radar or sonar processing system control, electronic countermeasures, electronic surveillance management, and digital flight control.

Variants/Upgrades

AYK-14(V) P3I. The AYK-14(V) Preplanned Product Improvement program was initiated to enhance the capabilities of existing weapons systems in US Navy inventory. The existing AYK-14(V) was found unable to meet the majority of identified TACAIR requirements beyond the year 1985. The P3I was begun as a response to new and urgent user operational requirements for the AV-8B, F/A-18, F-14D, V-22 aircraft and the Mk 50 torpedo.

In mid-1986 it became apparent that the P3I update was running into some fairly serious problems that were resulting in large-scale cost overruns. These problems centered on the computer's data processing speed. These problems have since been corrected with performance testing completed in February 1987, after achieving an unprecedented 1.67 million instructions per second (MIPS). The P3I AYK-14(V) replaces three of the AYK-14(V)'s processor module cards with a single module that is four times faster, with eight times the memory and twice the input capacity of current models. Production contracts for the AYK-14(V) P3I were issued in September with deliveries scheduled to start in 1989. Apparently, another US$30 million in developmental funding was previously committed to the new version of the AYK-14, with the emphasis on very large-scale integrated (VLSI) technology.

VPM. In 1986, Control Data Corp was awarded a developmental contract for the VHSIC (very high-speed integrated circuits) processor module (VPM) as a means of increasing processor performance and capacity. While it performs all the functions of the AYK-14(V) single-card processor (SCP), the VPM has additional capabilities including 32K words of cache memory (expandable to 128K words), up to 1024K (1M) words of onboard memory, and a reconfigurable I/O bus adapter. The VPM is packaged on a standard 6x9 ATR module for compatibility with current AYK-14(V) systems, or on an optional SEM-E module for use in new, advanced avionics applications. The VPM is said to provide eight times the processing performance of the basic AYK-14(V) and four times the performance of the P3I variant. The system was designed to equip the F/A-18 and F-14D, as these two programs expand their requirements throughout the mid-1990s. Aside from the above-mentioned aircraft, this program has the potential of equipping the entire inventory of existing systems. Initial production began in FY91.

Advanced AYK-14(V). This is a fourth-generation advanced airborne processor version of the AYK-14(V), and is called the Integrated Mission Computer (IMP) by its producers and the US Navy. Control Data initiated development work for the Advanced AYK-14(V) [AAYK-14(V)] in FY91. Development has focused on providing the bridge needed to evolve new and existing platforms to an Open System Architecture (OSA). Design features are said to include the following:

- A 50 MHz serial high-speed data bus (HSDB) module to alleviate F/A-18 input/output deficiencies and serve as the high-throughput bus for future-generation airborne computer standards.
- A reduced instruction set card (RISC) to enable communications between existing AYK-14 16-bit Compiler Monitor System (CMS-2) modules and

AYK-14 32-bit Ada modules for advanced applications. A MIPS 4400 microprocessor is utilized.

- An Interactive Voice I/O Module for the AV-8B to enable voice control of the mission computer, radios, and weapon system.
- An embedded Intel i860 video processor module set to reduce aircraft weight (by 43 lb.) and reduce video latency when switching between display formats (up to 10 seconds).
- A 32-bit AYK-14(V) configuration for the E-2C and other current-generation aircraft (embedded coprocessor).
- An embedded GPS module set.

Program Review

Background. Funded under Program Element 060457N Navy Tactical Computer Resources, Project W0845, the AYK-14(V) airborne data computer is derived from Control Data Corporation's CDC 480 microcomputer family. It provides for the development and production of a Navy Standard Airborne Computer capable of satisfying the airborne digital requirements throughout this decade at least. The hardware and software are integrated, resulting in standard government-furnished equipment. Testing and evaluation of additional standard avionics components continues, in parallel, towards qualification for the three services.

Upgrading of the AYK-14(V) was spurred when the US Navy signed a Joint Memorandum of Agreement with the US Army and the US Air Force in 1981 to promote interservice avionics components and subsystem development. In August 1987, Control Data Corp won a competition to supply an updated AYK-14(V) to the US Marines and US Air Force. The Marines began receiving their updated AYK-14(V) variants in 1989.

Control Data completed VHSIC (Very High Speed Integrated Circuits) development during FY90, with deliveries of the first VHSIC preproduction units made that year. The company began manufacturing the VPM (VHSIC Processor Module) AYK-14(V) variants in FY90, started production deliveries of the units, and continued follow-on development of state-of-the-art technology improvements for the AYK-14(V). These improvements were applied to the Advanced AYK-14(V) design and include a 50 MHz linear high-speed data bus, a video display module set, a voice interaction module, and 32-bit processor modules.

The prime contractor for the AYK-14(V) had long been Computing Devices International (formerly CDC), but the company has had to make room for competitors/ partners. In the spring of 1993, IBM Federal Systems (since purchased by Loral) won prime position for the RISC version AYK-14, with Computing Devices International named as second source. Computing Devices had previously accounted for 80 percent of the AYK-14(V) production work, with Unisys second-sourcing the rest. Computing Devices also lost prime position back in April 1988 when Paramax Systems Corp (then Unisys Computer Systems Division) was selected for the potential US$30 million buy-out contract on all the remaining production of the AYK-14(V); but by 1991 Unisys dropped out as AYK-14(V) second-source due to financial reasons, returning then-Control Data to sole, prime-producer status.

It was in mid-1992 that Control Data Corp was reorganized, with its defense unit, Government Systems Group, spun off as a new subsidiary called Computing Devices International. Its parent is now known as Ceridian Corp, one of two companies into which Control Data has split. That year the Navy selected the AAYK-14 Core Processor Set (CPS), including the RISC processor module and Futurebus+ backplane/chassis and associated configuration items, as the primary processing subsection for the LAMPS Mk III Block 2 Integrated Mission Processor (IMP) on the SH-60B ASW helicopter, with then-IBM as the avionics integrator for the effort. Preliminary specifications were also completed for the future development of AYK-14 modules, including the high-speed data bus module, GPS module, and display processor modules. The Navy continued development of the CPS (Core Processor Set) in FY93, and also evaluated design, test, and qualification requirements to bring other Futurebus+ Open System Architecture (OSA) module developments into the AYK-14 family.

Work for FY94 completed the design and initial production of a full-up SH-60 Integrated Mission Processor AAYK-14 (called IMP by its developers, in keeping with the Navy's trend toward using ruggedized commercial products rather than custom-made military equipment). Testing of the IMP began, including interoperability testing between existing AYK-14 16-bit CMS-2 modules and new-design 32-bit Ada modules. This effort tested integration of the RISC card with its MIPS 4400 microprocessor on the AYK-14 to handle the Pentagon's Ada language, with the older CMS-2 Navy software running through the AYK-14 portion itself. The program also included work on the V-22 Osprey, to coordinate the

integration of AAYK-14(V) technology into the V-22's Advanced Mission Computer (AMC); both preliminary design and critical design reviews were performed.

Through FY95, the focus of the project has been to create compatibility and adaptability via Open Systems Architecture (OSA). To that end, recent efforts have centered around the development of a backplane based on the Institute of Electrical and Electronic Engineers (IEEE)/Next Generation Computer Resources (NGCR) OSA standard Futurebus+ interface, as well as other means of enabling the AYK-14 to communicate with other modules for multi-user requirements. Efforts were also continued in the area of militarizing commercial OSA products to fit the AAYK-14 family. Specific program activities centered on AAYK-14 development for three aircraft: the SH-60, the V-22 Osprey, and the EA-6B Prowler. Qualification testing was conducted and reliability development testing was begun for the SH-60B IMP/AAYK-14. Engineering and manufacturing development for the V-22 AMC/AAYK-14 was completed. Technology transfer of AAYK-14 to the EA-6B mission processing upgrade was also begun.

Ambitious schedules were planned for FY96. That year, engineering and manufacturing development and integration of the SH-60 IMP/AAYK-14 were completed. The AAYK-14 technology transfer for EA-6B mission processing upgrade was completed as well. Militarization of OSA commercial products for the AAYK-14 family is being continued.

Advanced Mission Computer. In the FY97/98 budget description the AAYK-14 program had been redefined and redesignated the Advanced Mission Computer (AMC) program. The AMC will use the AAYK-14 as the basis for the AMC. The new project is geared to provide an airborne digital computer using a standard commercial open architecture that will allow for the rapid deployment of new technologies via preplanned product improvements. The primary purpose of the open system is to allow for the integration to existing platforms of a Higher Order Language (HOL) and high-speed bus architecture.

The AMC will also include the following:

- Integration of commercially-based processors, development of input/output, and additional special function modules
- Backplane development based on commercial industry standards
- Support of additional design, test, and qualifications necessary to meet multi-user requirements as well as to bring other programs NDI/COTS modules into the AMC-based open system

The designated lead user for the AMC is the F/A-18 E/F with potential users including the SH-60R, V-22, AH-1W, EA-6B, and F/A-18 C/D.

Current plans for FY98/99 include the continued development, testing and integration of the AMC to the F/A-18 E/F, achievement of Milestone II status, and coordination of the use of AMC for multiservice applications.

Funding

US FUNDING

	FY97		FY98		FY99		FY00(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (USN) PE#0604574N Navy Tactical Computer Res. Project W0845 Adv. Mission Comp. (AMC)	-	1.1	2	1.1	23	5.0	16	9.8

	FY01(Req)		FY02(Req)		FY03(Req)		FY04(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
AMC	-	15.6	-	6.5	-	5.8	-	Cont.

All US$ are in millions

Funding information gathered from the 1998/1999 US Biennial RDT&E Descriptive Summary.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Ceridian Corp	8.4	Jan 1995 – Fixed-price, indefinite delivery/indefinite quantity requirements contract for 48 AYK-14(V) airborne mission computers for the F/A-18 aircraft. Completed March 1997 (N00163-93-D-0006)
Ceridian Corp	12.6	March 1995 – Fixed-price delivery order under an indefinite delivery/indefinite quantity requirements contract for 129 kits for the upgrade of AYK-14(V) airborne mission computers for the F/A-18 aircraft. Completed October 1996 (N00163-93-D-0006)
Ceridian Corp	9.4	May 1995 – Fixed-price delivery order under an indefinite delivery/indefinite quantity requirements contract for 96 ECP-45 kits for the upgrade of AYK-14(V) airborne mission computers for the F/A-18 aircraft. Completed May 1996 (N00163-93-D-0006)
Northrop Grumman	33.5	Nov 1995 – Participation in the upgrade of four aircraft to a baseline Block 89A configuration. Northrop to engineer the installation of navigation, communications and aircraft systems and upgraded AYK-14 computer hardware, and produce, deliver and install component kits for the Navy. To be completed in March 1998.
Ceridian Corp	8.8	Mar 1996 – Delivery order to procure 90 mission computer upgrade kits for the F/A-18 aircraft. Completed April 1997. (N00163-96-D-0014)
Ceridian Corp	6.1	May 1996 – Delivery order to procure 36 mission computers for the Finnish Air Force F/A-18 program. This purchase is for the government of Finland under the FMS program. To be completed by May 1999. (N00163-96-D-0014)

Timetable

	1976	Competitive source selection
Sep	1976	Control Data Corp (CDC) awarded contract for design, development, test, and delivery
Oct	1977	Preproduction units delivered
	1982	Completed delivery of pre-production units
Late	1982	Initial production deliveries
	1984	Designated standard Naval airborne computer
Jan	1984	Unisys (Sperry) selected as second-source supplier
	1985	AYK-14(V) P^3I initiated
	1986	Sperry and Burroughs merge to form Unisys
Feb	1987	AYK-14(V) P^3I performance testing completed
Apr	1987	AYK-14(V) design review completed
Sep	1987	First AYK-14(V) P^3I production awards
	FY88	Initial P^3I production
Dec	1988	VHSIC AYK-14(V) flight testing on USN EA-6B
	FY89	Deliveries of P^3I units began
	FY91	Initial VPM production scheduled; Unisys dropped as second-source
Jun	1992	Control Data split off Government Systems Group and renamed it Computing Devices International
	1993	IBM Federal Systems named prime contractor for Advanced AYK-14
	1994	Preliminary and Critical Design review, implementation into V-22 began
	FY95	Began reliability Developmental Test
	FY96	Advanced AYK-14(V) (AAYK-14 (V)) becomes available
	FY1997	Begin technology shrink of existing Advanced AYK-14 units to fit F/A-18 E/F
	FY1997	AYK-14 redesignated the Advanced Mission Computer (AMC)

Worldwide Distribution

Note: The number of AYK-14(V) computers per aircraft is as follows:

A-4, AV-8B, EAV-8B, SH-60B/F – 1 per aircraft
F/A-18, F-14, EA-6B, S-3B, E-2C, V-22 – 2 per aircraft
P-3C, CP-140 – 3 per aircraft
Aircraft distribution is as follows:
Australia – 71 F/A-18s [giving a total of 142 AYK-14(V)s]; 21 P-3Cs [42 AYK-14(V)s]
Canada – 125 F/A-18s [250 AYK-14(V)s]; 30 CP-140s [90 AYK-14(V)s]
Egypt – 6 E-2Cs [12 AYK-14(V)s]
Japan – 13 E-2Cs [26 AYK-14(V)s]
Kuwait – 40 F/A-18s [80 AYK-14(V)s]
Netherlands– 14 P-3Cs [42 AYK-14(V)s]
Norway – 4 P-3Cs [12 AYK-14(V)s]
Singapore – 4 E-2Cs [8 AYK-14(V)s]
Spain – 71 F/A-18s [142 AYK-14(V)s]; 10 EAV-8Bs [10 AYK-14(V)s]; 6 SH-60Bs [6 AYK-14(V)s]
United States – US Navy/USMC: 95 E-2Cs [190 AYK-14(V)s]; 127 EA-6Bs (upgrade in progress); P-3C; F-14A/A+; F-14D; 896 F/A-18s (All Variants) [1,792 AYK-14(V)s]; 237 SH-60B/Fs [237 AYK-14(V)s]; 150+ V-22s (All Variants) [300 AAYK-14 or AMC units]

Forecast Rationale

The AYK-14 computer has been in service in one form or another for over two decades. This unit has equipped almost every US Navy, and a majority of the US Marine Corps', aviation platforms from fighters down to helicopters. In addition, foreign sales have also been brisk, as those countries flying similar equipment have sought to upgrade their platforms with the more advanced AYK-14 units.

While continuing RDT&E funding remains relatively low, at an average of US$1.26 million (1998 dollars) per year, this is not to be taken as an indication of a stagnant program. The core of the system has operated so efficiently that only minor adjustments to the unit were needed to incorporate either new technology and/or software. Known expenditure breakouts include the achievement of Milestone II status, continued development and integration into the F/A-18E/F, and acquiring of COTS technology for Open Systems mission processors, high-speed buses, and Higher Order Languages (HOL). The culmination of these expenditures will lead the AAYK-14 variant designated the Advanced Mission Computer (AMC).

The AMC is geared to provide an airborne digital computer using a standard commercial open architecture that will allow for the rapid deployment of new technologies via preplanned product improvements. The primary purpose of the open system is to allow for the integration to existing platforms of HOL and high-speed bus architecture. The AMC will also include the following:

- Integration of commercially based processors, development of input/output, and additional special function modules
- Backplane development based on commercial industry standards
- Support of additional design, test, and qualifications necessary to meet multi-user requirements as well as bringing other programs' NDI/COTS modules into the AMC-based open system

The AYK-14(V) airborne data computer or one of its derivatives will continue to serve as the US Navy standard well into the next decade. While AYK-14(V)'s primary application is on tactical aircraft, the system also finds use on a variety of land and sea applications such as the Navy's CAINS and ACLS landing systems, as well as the Joint STARS TSQ-32 ground station module. Production will average approximately 213 units per year through the 10-year forecast with units per year falling below 200 only in the last two years of the forecast. This will be due to the end of export orders and USN upgrades.

The only remaining significant new-build and upgrade programs will most likely carry the AYK-14 AMC variant. These programs include the F/A-18E/F, V-22, and the upgrading of the SH-60R, AH-1W, F/A-18C/D, and EA-6B. It is known that all F/A-18E/Fs will have the AMC installed. It is also possible that older aircraft will be upgraded to the AMC, but there has been no indication that this will occur. Foreign orders for the AMC, if allowed, will probably not occur until very late in the forecast period.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level			Good Confidence Level				Speculative			
Designation	Application	thru 97	98	99	00	01	02	03	04	05	06	07	Total 98-07
AYK-14(V)	E-2C (EXPORT)	80	6	4	6	2	2	0	0	0	0	0	20
AYK-14(V)	E-2C (USN) (a)	292	8	10	10	12	12	10	0	0	0	0	62
AYK-14(V)	EA-6B (USN)	320	5	0	0	0	0	0	0	0	0	0	5
AYK-14(V)	EA-6B UPGRADE (USN) (b)	0	8	20	30	48	48	48	30	0	0	0	232
AYK-14(V)	F/A-18A/B/C/D (USN/USMC)	2016	26	0	0	0	0	0	0	0	0	0	26
AYK-14(V)	F/A-18C/D (FINLAND)	44	24	24	24	12	0	0	0	0	0	0	84
AYK-14(V)	F/A-18C/D (KUWAIT)	84	12	8	4	0	0	0	0	0	0	0	24
AYK-14(V)	F/A-18C/D (MALAYSIA)	16	0	8	8	0	0	0	0	0	0	0	16
AYK-14(V)	F/A-18C/D (SWITZERLAND)	28	24	16	0	0	0	0	0	0	0	0	40
AYK-14(V)	F/A-18C/D (UAE)	48	20	0	0	0	0	0	0	0	0	0	20
AYK-14(V)	F/A-18E/F (USN)	15	0	10	26	51	75	75	75	75	75	75	537
AYK-14(V)	SH-60B (EXPORT)	54	10	10	10	8	0	0	0	0	0	0	38
AYK-14(V)	SH-60B/F (USN) (c)	278	0	3	12	18	24	35	35	35	35	0	197
AYK-14(V)	V-22A (USMC/USAF)	19	2	11	15	21	25	38	56	66	88	88	410
AYK-14(V)	VARIOUS (EXPORT)	384	48	48	48	36	36	30	30	0	0	0	276
AYK-14(V)	VARIOUS (USN)	504	48	48	48	0	0	0	0	0	0	0	144
AYK-14(V)	Prior Prod'n:	3594	0	0	0	0	0	0	0	0	0	0	0
Total Production		7776	241	220	241	208	222	236	226	176	198	163	2131

(a) The upgrading of the E-2C platform may not occur. However, due to the previous upgrading of the vast majority of the E-2C flee fleet it is felt that the US Navy will finish upgrading these platforms.

(b) The time frame of these EA-6B upgrades corresponds to the probable initial production of the Advanced Mission Computer (AMC). These upgrades could be either the AAYK-14(V) or the AMC variant.

(c) A total of 188 SH-60B/F models are to be reconfigured into the SH-60R models to include the introduction of the AAYK-14(V) Advanced Mission Computer (AMC) variant.