AIRCRAFT INTERROGATION AND DISPLAY SYSTEM:
A GROUND SUPPORT EQUIPMENT FOR DIGITAL FLIGHT SYSTEMS

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INTRODUCTION

The National Aeronautics and Space Administration (NASA) is conducting research in many areas involving advanced digital systems for both manned and unmanned aircraft, and in ground-based simulators. As these various types of digital flight systems have become more complex, the need has arisen for more sophisticated ground support equipment (GSE) for systems integration, software verification and validation, pre- and postflight testing, and system maintenance. Until recently, the approach taken was for each project to procure special purpose GSE, resulting in a multiplicity of different types of equipment of varying capability. These types of GSE generally were single purpose and were surplussed at the termination of the project. Usually, none of the GSE development investment could be recouped for the next project.

As an approach to a resolution of this problem, the NASA Dryden Flight Research Facility undertook the development of a microprocessor-based user-programmable general purpose GSE, termed aircraft interrogation and display system (AIDS). A prototype was constructed, interfaced with the F-8 digital fly-by-wire (F-8 DFBW) iron bird simulator, and used successfully to support F-8 flight software verification and validation. The general purpose utility of the AIDS was confirmed when applied to the highly maneuverable aircraft technology (HiMAT) project. Using new software, the prototype was easily interfaced with the HiMAT aircraft, and it quickly demonstrated its capability by providing a fortyfold increase in random access memory (RAM) data display bandwidth.

The utility of the AIDS during HiMAT flight control computer testing and systems integration validated the flexibility of the system and led to plans to apply it to other projects. Two AIDS systems are in service, and a third is under construction. The total number of present and planned users is five. This paper describes the AIDS design and mechanization, summarizes operational experience to date, and discusses plans for the future.

The use of trade names or names of manufacturers in this report does not constitute an official endorsement of such products or manufacturers, either expressed or implied, by the National Aeronautics and Space Administration.

SYMBOLS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/D</td>
<td>analog-to-digital converter</td>
</tr>
<tr>
<td>AFTI</td>
<td>advanced fighter technology integration</td>
</tr>
<tr>
<td>AIDS</td>
<td>aircraft interrogation and display system</td>
</tr>
<tr>
<td>ARW</td>
<td>advanced research wing</td>
</tr>
<tr>
<td>ASCII</td>
<td>American standard code for information interchange</td>
</tr>
<tr>
<td>ASEG</td>
<td>absolute segment</td>
</tr>
<tr>
<td>C&amp;D</td>
<td>controls and displays</td>
</tr>
<tr>
<td>CPU</td>
<td>central processing unit</td>
</tr>
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</table>
A significant amount of experience was gained during the F-8 DFBW program in the formulation and use of display and driver GSE devices for flight control design, development, verification and validation, troubleshooting, maintenance, preflight testing, and research experimentation (ref. 1). The ground display software was implemented in the F-8 DFBW flight computer itself and consisted of several dedicated and special purpose displays, including system redundancy management status, dynamic sensor data, aircraft system status, failure status, and preflight test and maintenance results.
Although the display system was highly refined and was a key element in the successful development of the fly-by-wire system, it had several drawbacks. First, the display system was designed to operate integrally with the triple-redundant digital fly-by-wire control system, and as such it had to be nonintrusive; that is, the display functions could not alter flight control system operation. This complicated the display system software. Second, the display system required a modest but not negligible share of the flight computer cycle time and memory resources. Third, the display software required a relatively high level of verification because it resided in the flight computer, even though it was never executed in flight. Finally, the system was not portable, and it could not be used on other aircraft programs.

The driver software used for verification and validation tests, such as triplex sensor fault detection, isolation, and recovery, was implemented in the mainframe computer used for aerodynamic simulation. Special purpose pulses, waveforms, and noise signature signals were generated by the driver software and interfaced to the flight computer sensor input processor. Although highly successful, this approach required substantial amounts of simulation computer time for relatively simple computational tasks at a time when the simulation computer served multiple users.

The experience, advantages, and disadvantages of the various approaches used on the F-8 DFBW program, as well as other flight system research projects, laid the foundation for the AIDS design.

**DESIGN OBJECTIVES**

The AIDS was originally conceived as a stand-alone general purpose ground support equipment device for aircraft digital flight control systems that had the display and driver capabilities of the GSE used for the F-8 DFBW. Early in the conceptual design it was determined that many other applications would be possible for this device. For that reason, design objectives were established that would guarantee the system's generality and flexibility. These design objectives included:

**Mobility.** The system should be capable of being moved between laboratories, iron bird, and aircraft.

**Flexible input/output.** The system should be easy to interface with digital and analog systems, be independent of the system-under-test architecture, and minimize that system's servicing burden.

**Common core software support package.** The system should provide a large share of commonly used display and driver functions for digital flight systems, including (a) number conversion to any desired format and engineering units calibration, (b) bit unpacking and display as event, (c) snapshot block data, (d) parameter trace, (e) data recording or plotting as stripchart or X-Y parameters, and (f) waveform drivers for redundant flight control sensors.

**User-oriented displays.** The displays should have dynamically refreshed display and provide for user formatting and labeling. Free-form display formats should be available that can be easily constructed in real time (during a test procedure) as new requirements develop. The operator should have the ability to interrupt a display at any time, make modifications to the format, and resume the display within a few seconds. In addition, the operator should have the ability to make display hard copies at any time. Such hard copies should be labeled with date, time, test title, and any other user-determined information.
Utilization of commercial components. Where possible, the system should use commercially available card-level microcomputer hardware and commercial software. This enhances long-term maintenance and minimizes development costs.

Speed. The system should be able to service flight control systems with cycle rates on the order of 50 to 100 samples per second.

Synchronization. The system should acquire and display snapshots of several data words occurring within one computer cycle frame (10 to 20 milliseconds).

Maintenance. The system should contain an integral diagnostic and maintenance support capability.

Operational modes. The system should be easily and quickly convertible between the operating modes shown in figure 1, including real-time data display, open-loop function generator, redundant sensor simulator, and simple closed-loop simulation (a simulation at a single flight condition with linear equations of motion).

FUNCTIONAL DESCRIPTION

The first AIDS device that was developed generally met the design objectives. The AIDS was designed around an 8085A microprocessor system. A diskette subsystem was incorporated which was fully compatible with the off-line support software used to create the AIDS software load modules. A commercially available real-time multitasking executive (RTMTX) was also incorporated, mainly for the management of the diskette drives and diskette directory services.

Figure 2 illustrates the functional arrangement of the AIDS. The particular operating mode is defined by the software modules contained on the system diskette. Any user displays that were previously created are stored on the scratch diskette. These two diskettes are accessed via the real-time multitasking executive software that is permanently recorded on programmable read-only memory (PROM) integrated circuits. The remaining system software is loaded from the system diskette by the RTMTX, and the display formats are loaded from the scratch diskette by the RTMTX as needed. The RTMTX then transfers control of the system to the software loaded, but remains available for subsequent diskette operations and other multitasking as required.

The AIDS supervisor module and companion operator input/output (I/O) modules are software that is common to all users. The supervisor provides command interpreting, software linking, a date register, an updated time-of-day register, and various system control functions. The I/O package provides the main operator interfaces to the control keyboard, the cathode ray tube (CRT) data display, and the hard copy peripherals. The operator enters system commands and display setup instructions via the control keyboard (KB). All displays are presented on the CRT display, which is refreshed at high speed on those areas of the screen which contain active (nonstatic) fields. Hard copies of any display may be made either by operator command or under supervisor control as desired.

User-unique software includes the user application supervisor, user timing control, and one or more user I/O modules. The user application supervisor provides servicing for user interrupts and interfaces with the RTMTX as required. The user timing control module provides basic timing for all user I/O and supporting computation. The user I/O servicing module services the data path to and from the system under test and provides for auxiliary analog outputs to nonAIDS peripheral devices as required.
Real-time data display:

Open-loop function generator:

Redundant sensor simulator:

Closed-loop simulation:

Figure 1. Examples of conceptual AIDS applications.
Figure 2. AIDS functional overview.
HARDWARE DESCRIPTION

Figure 3 shows the mechanization of the current AIDS design. The entire system is mounted in a two-bay console that is mounted on wheels for mobility. The five major components are the computing subsystem, the I/O panel, the diskette drive subsystem, the operator terminal, and the line printer. The user must supply the appropriate cable(s) to mate the system under test to the I/O panel.

Appendix A contains a bill of materials for the major components of the present AIDS mechanization. The fabrication of the computing subsystem was quickly achieved using an industrial chassis incorporating a 12-slot card cage and integral power supply. Minor modifications to the chassis control panel were required to provide for a PROM set select switch, a bus timeout monitor indicator, and several test points. These additions are interfaced to the computing subsystem via circuitry on the universal prototype board.

The various computing subsystem boards listed in appendix A are I/O mapped as shown in figure 4 and memory mapped as shown in figure 5. The central processor unit (CPU) board contains an 8085A microprocessor, which provides adequate computational capability for currently planned operating modes. Table 1 shows the assignment of system interrupts.

The floppy diskette drive unit is a dual-drive single density standard sized diskette system. It interfaces directly to the floppy diskette controller board in the computing subsystem. The single density format provides more than ample storage capability. One drive is used for system program modules, and the other is used for scratch file storage.

The operator terminal is a single unit with a full sized black and white CRT screen and full keyboard. The CRT and keyboard are interfaced to the computing subsystem via a full duplex serial port on system expansion board A. High speed refresh of the CRT display is performed in vectored cursor mode at 1920 characters per second. A minor terminal modification was necessary to provide software control over the cursor marker on the screen. This was achieved by rewiring the keyboard enable/disable flip-flop, which is under software control, to the cursor blanking circuit. This allows the cursor to be blanked during screen refresh operations, resulting in a flicker-free display. The keyboard has been wired permanently enabled.

The line printer is a 5 by 7 dot matrix printer with a dual channel vertical forms unit that allows the proper pagination of all system printouts. The interface to the computing subsystem is via a parallel discretes port on the central processor board.

The I/O panel is a NASA-designed and -constructed unit which provides the user an interface with the computing subsystem for analog and discrete signals. Figure 6 shows the signal paths within the I/O panel. The connectors for the user interface cable(s) are located on the rear of the AIDS cabinet. For each discrete, monitoring jacks and light-emitting diode (LED) indicator lamps are provided on the front of the I/O panel. Internal to the I/O panel are line drivers and receivers for the discretes, which provide the user with a balanced differential double-rail interface. The receivers interface to the computing subsystem via system expansion board A, and the drivers interface via system expansion board B. With regard to analog trunks, the I/O panel is passive and provides only breakout jacks on the front panel. The analog inputs interface with the computing subsystem via the analog input board, which scans the inputs using a ±10 volt balanced multiplexer. The ±10 volt unbalanced analog outputs from the computing subsystem are fed from the four analog output boards.
Figure 3. Aircraft interrogation and display system.
Figure 4. AIDS I/O address map.
Figure 5. AIDS memory map.
TABLE 1.—AIDS INTERRUPT ALLOCATION

<table>
<thead>
<tr>
<th>Level</th>
<th>Assignment</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trap</td>
<td>Not used</td>
<td>----</td>
</tr>
<tr>
<td>A</td>
<td>Bus timeout</td>
<td>AIDS tally only</td>
</tr>
<tr>
<td>B</td>
<td>Not used</td>
<td>----</td>
</tr>
<tr>
<td>C</td>
<td>Not used</td>
<td>----</td>
</tr>
<tr>
<td>0</td>
<td>INTR pushbutton</td>
<td>User manual interrupt</td>
</tr>
<tr>
<td>1</td>
<td>Timer no. 0</td>
<td>RTMTX task wait timer</td>
</tr>
<tr>
<td>2</td>
<td>Disk controller</td>
<td>RTMTX diskette I/O</td>
</tr>
<tr>
<td>3</td>
<td>Timer no. 1</td>
<td>User clock</td>
</tr>
<tr>
<td>4</td>
<td>External interrupt</td>
<td>User sync</td>
</tr>
<tr>
<td>5</td>
<td>1 Hz interrupt</td>
<td>AIDS time of day clock</td>
</tr>
<tr>
<td>6</td>
<td>USART C receiver</td>
<td>RTMTX terminal handler</td>
</tr>
<tr>
<td>7</td>
<td>USART C transmitter</td>
<td>RTMTX terminal handler</td>
</tr>
</tbody>
</table>
Figure 6. AIDS I/O paths.
SOFTWARE DESIGN

Two separate software systems are resident within the AIDS. They are alternately accessible to the operator via a PROM select switch on the front of the computing subsystem chassis. One system is the maintenance and diagnostic software system, which consists of a commercial monitor package designed for the central processor board plus a NASA-designed set of extension routines. This package, which is stored as firmware on two PROMs that are installed on the central processor board, is executed when the PROM select switch is in the "monitor" position. This software provides basic AIDS troubleshooting services and diskette subsystem test routines.

The second software system is the main AIDS hierarchy, which consists of the components shown in figure 7. This software structure is shown from bottom to top in the order the four components become active in the system. The first component to execute is the RTMTX, which is a commercial package designed to be used with the central processor board and provides diskette subsystem services. This package is stored as firmware on eight PROMs installed on the system expansion boards and is executed when the PROM select switch is in the "disk" position. The remaining three software components are loaded into the AIDS memory from the system diskette in drive 0, and are mapped as shown in figure 8.

Embedded in the RTMTX firmware is a configuration module that defines the characteristics and mapping of the diskette subsystem hardware. It also specifies the tasks to be created when the system is initialized. The task list includes the diskette drive controller board handler, the diskette I/O handler, several diskette directory servicing routines, the full terminal handler, and the bootstrap loader. These routines and associated variables are accessible via PUBLIC labels, which can be linked to user code. Since the RTMTX code requires no maintenance, the PROM set never requires reprogramming and the integrity of the hardware is enhanced. Appendix B contains a listing of the configuration module and the SUBMIT file used to create the RTMTX firmware.

When the AIDS is powered up (or reset) with the PROM select switch in the "disk" position, the RTMTX begins executing and sets up the tasks specified by the configuration module. When the bootstrap loader becomes the active task, it seeks a file called RMXSYS on the system diskette, loads it into random access memory, and starts executing it. The file :F0: RMXSYS always contains the AIDS supervisor task module component of the AIDS software hierarchy. Once loaded, this module assumes central control of the system and is the point to which all other components return when execution is completed.

The AIDS supervisor contains an initialization routine followed by a looping command interpreter routine. It also contains many routines which are commonly needed by the different AIDS users. These include the CRT/KB handler, printer handler, analog I/O drivers, scratch diskette librarian, time-of-day clock, display data formatters, and utility routines. These can be accessed by a user via hard-mapped linkages in the common data area.

One of the functions performed by the AIDS supervisor during the initialization procedure is to request the RTMTX to load a module called USER from the system diskette. The file :F0: USER always contains the user main module component of the software hierarchy. Within it are contained the user interrupt servicing routines, user I/O packages, and an initialization subroutine. It also contains tables defining the syntax for user commands and user scratch file load control.
Figure 7. AIDS software hierarchy.
Figure 8. AIDS RAM allocation.
The fourth component of the AIDS software hierarchy are overlays. Overlay modules are generally loaded and executed in response to a keyboard command, and they always provide a specific function. They are linked to the remaining software via absolute entry addresses within the overlay area and, like the USER main module, have access to AIDS supervisor subroutines and variables via the common area. In general, each overlay has associated with it a unique display which is presented on the CRT. Overlays may be either system or user related. Most are operator interactive, and all must exit back to the AIDS supervisor when the KB escape key is pressed. System overlays provide functions such as interrupt control, printer moding, clock management, and I/O panel monitoring. User overlays are not restricted as to function but must conform to the mapping, linkage, and escape conventions required of all AIDS overlays.

Taken as a whole, the design of the AIDS software is intended to provide a multitasking environment within which the various system and user tasks can share a single CPU. The lowest priority task is always the servicing of the operator interface, which includes the CRT, KB, and printer. All higher priority tasks are invoked by interrupts, which require temporarily halting the operator I/O. A typical user application might involve responding to a sync interrupt from the system under test, inputting data, performing computations, outputting data, and setting up a data buffer for the current operator display. As the amount of time required to service such an interrupt increases, the most noticeable effect is the slowing of CRT screen refresh. Another variable that affects screen refresh is the amount of data being displayed, since there is computational overhead associated with formatting as well as screen write operations. The performance of the AIDS in various applications will be later quantified as a duty cycle or percentage of time which is devoted to interrupt-driven code execution as opposed to operator I/O.

USER EXPERIENCE

Since 1978, the AIDS has been employed in support of three research projects and is planned for use in at least two others. Two AIDS units are in active use, and a third unit is soon to enter service. The F-8 DFBW iron bird application (ref. 1) allows closed-loop aerodynamic simulation and redundant sensor fault emulation, providing valuable support in software verification and validation. The HIMAT remotely piloted research vehicle application (ref. 2) provides open-loop display of onboard computer memory data. It is used extensively in support of simulation, preflight testing, and system troubleshooting. Another user project is an experimental nodal network data bus breadboard (ref. 3). For this project the AIDS provides test set capability for the I/O processor in each node and monitors bus message traffic. A planned future application is support for the AFTI/F-111 project (ref. 4) where the AIDS will monitor the interchannel message traffic within the redundant flight system. Another future application is support for the DAST ARW-II project (ref. 5), where the AIDS will provide test set capability for a multiprocessor flight computer as well as provide the usual data display functions.

One measure of the performance of the AIDS is the loading or level of saturation of its central processor for each application. Loading may be defined as the duty cycle or percentage of time required to perform time-critical (interrupt-linked) computational tasks as opposed to operator I/O functions. The duty cycle ranges from 90 percent for the F-8 DFBW simulation to 10 percent for the HIMAT data display function. Screen refresh rates for the F-8 DFBW are very low (typically 0.5 per second). For a typical HIMAT display, however, the refresh rate is comfortably high (4 per second). The time required to perform a line printer hard copy of a display snapshot is roughly proportional to the refresh rate of the display and varies from 20 seconds to 5 seconds.
The HiMAT application best demonstrates the capabilities of the AIDS, and it has accumulated the most AIDS operating time, with over 2000 hours in a 3 year period. This application grew out of the need to augment the data display capability of the manufacturer-supplied GSE, called the system test console (STC). The STC mates with the HiMAT aircraft umbilical connector, and one of its functions is to allow the contents of the onboard computer memory to be examined. However, the STC can only display a single byte as a bit pattern expressed in octal digits, severely limiting the visibility of the functioning of the onboard computer.

To provide the needed additional display capability, the AIDS was connected to the STC as shown in figure 9. The 16 address lines are tied in common to the STC thumbwheels used for manual RAM address selection. The 8 data lines are tied to the output from the onboard computer, which feeds the decoders driving the STC octal display. The AIDS sequentially outputs an address, waits for a sync pulse from the onboard computer, and then reads the RAM data byte output by the computer. This sequence is repeated every 20 milliseconds, which is the rate at which the onboard program services the test console interface.

The AIDS operator controls which addresses are to be read by creating with KB inputs a formatted CRT display (called a page) that specifies by data type and RAM memory location, which items are desired. Table 2 shows the different data display formats available to the operator. Of these, only codes VG and DG (specially scaled fixed-point formats for the vertical gyro and directional gyro, respectively) are unique to HiMAT. Note that a single data item causes from 1 to 15 successive RAM addresses to be read. The AIDS software builds an address table based on the display requirements and scans this table repetitively. As the data is returned, it is buffered, formatted for display, and presented on the CRT in a continuously refreshed mode.

Appendix C contains hard copies of representative HiMAT displays. Also shown is a typical scratch diskette directory page and a hard copy of the command interpreter display, which lists the system and user commands available. The HiMAT project uses these display pages and others to support software verification and validation, system maintenance, preflight and postflight tests, and closed-loop simulations. Over 100 display page formats of various types have been created and placed on scratch diskette. The AIDS has become an integral part of such critical testing as the preflight test, where AIDS data dumps are written into several procedure sequences. The ability to select a scratch diskette and quickly (in 1 to 3 seconds) load any of up to 45 display page files has been of great benefit to the HiMAT project. In addition, the inherent flexibility of the software system has been demonstrated repeatedly by the changes that have easily been implemented in response to project engineering request.

CONCLUDING REMARKS

General purpose user-programmable ground support equipment has been developed and placed in service in support of both aircraft and simulation facilities. Three years' experience involving several users has demonstrated the utility of the system concept and created a demand for additional systems to support future users. The flexibility of the concept has been demonstrated in a wide range of applications, including real-time data acquisition, software verification and validation, system integration testing, and real-time closed-loop simulation.

The major contribution of the system, known as the aircraft interrogation and display system (AIDS), has been its ability to make visible the functioning of a digital flight program.
**Figure 9. AIDS to HiMAT interface.**
## Table 2. AIDS Data Display Formats

<table>
<thead>
<tr>
<th>Number</th>
<th>Code</th>
<th>Number of bytes</th>
<th>Number of bits</th>
<th>Data type</th>
<th>Sign?</th>
<th>Number of columns</th>
<th>Display format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H1</td>
<td>1</td>
<td>8</td>
<td>Any</td>
<td>---</td>
<td>2</td>
<td>HH</td>
</tr>
<tr>
<td>2</td>
<td>H2</td>
<td>2</td>
<td>16</td>
<td>Any</td>
<td>---</td>
<td>4</td>
<td>HHHH</td>
</tr>
<tr>
<td>3</td>
<td>H3</td>
<td>3</td>
<td>24</td>
<td>Any</td>
<td>---</td>
<td>6</td>
<td>HHHHHHHH</td>
</tr>
<tr>
<td>4</td>
<td>H4</td>
<td>4</td>
<td>32</td>
<td>Any</td>
<td>---</td>
<td>8</td>
<td>HHHHHHHHHH</td>
</tr>
<tr>
<td>5</td>
<td>B1</td>
<td>1</td>
<td>8</td>
<td>Any</td>
<td>---</td>
<td>8</td>
<td>BBBB</td>
</tr>
<tr>
<td>6</td>
<td>B2</td>
<td>2</td>
<td>16</td>
<td>Any</td>
<td>---</td>
<td>16</td>
<td>BBBB</td>
</tr>
<tr>
<td>7</td>
<td>F4</td>
<td>4</td>
<td>32</td>
<td>Floating point</td>
<td>Y</td>
<td>10</td>
<td>[ - ]DDDDDDD.DDDD</td>
</tr>
<tr>
<td>8</td>
<td>I1</td>
<td>1</td>
<td>8</td>
<td>Integer</td>
<td>N</td>
<td>4</td>
<td>_</td>
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<td>I2</td>
<td>2</td>
<td>16</td>
<td>Integer</td>
<td>N</td>
<td>6</td>
<td>DDDDD</td>
</tr>
<tr>
<td>10</td>
<td>D1</td>
<td>1</td>
<td>8</td>
<td>Integer</td>
<td>Y</td>
<td>4</td>
<td>[ - ]DDDD</td>
</tr>
<tr>
<td>11</td>
<td>D2</td>
<td>2</td>
<td>16</td>
<td>Integer</td>
<td>Y</td>
<td>6</td>
<td>[ - ]DDDDDD</td>
</tr>
<tr>
<td>12</td>
<td>DD</td>
<td>2</td>
<td>12</td>
<td>DAC value</td>
<td>Y</td>
<td>6</td>
<td>HHH</td>
</tr>
<tr>
<td>13</td>
<td>DH</td>
<td>2</td>
<td>12</td>
<td>DAC value</td>
<td>Y</td>
<td>7</td>
<td>[ - ]DDD.DDD</td>
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<td>14</td>
<td>DV</td>
<td>2</td>
<td>12</td>
<td>DAC value</td>
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<td>000</td>
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<td>Any</td>
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<td>000</td>
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<td>Any</td>
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<td>ASCII string</td>
<td>---</td>
<td>1</td>
<td>A</td>
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<tr>
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<td>A2</td>
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<td>---</td>
<td>ASCII string</td>
<td>---</td>
<td>2</td>
<td>AA</td>
</tr>
<tr>
<td>19</td>
<td>A3</td>
<td>3</td>
<td>---</td>
<td>ASCII string</td>
<td>---</td>
<td>3</td>
<td>AAA</td>
</tr>
<tr>
<td>20</td>
<td>A4</td>
<td>4</td>
<td>---</td>
<td>ASCII string</td>
<td>---</td>
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<td>AAAA</td>
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<td>A5</td>
<td>5</td>
<td>---</td>
<td>ASCII string</td>
<td>---</td>
<td>5</td>
<td>AAA AA</td>
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<td>A6</td>
<td>6</td>
<td>---</td>
<td>ASCII string</td>
<td>---</td>
<td>6</td>
<td>AAAAA AAAAA</td>
</tr>
<tr>
<td>23</td>
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<td>ASCII string</td>
<td>---</td>
<td>7</td>
<td>AAAAAA</td>
</tr>
<tr>
<td>24</td>
<td>A8</td>
<td>8</td>
<td>---</td>
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**Display format key:**

- **H** = hexadecimal digit 0 to 9, A to F
- **B** = binary digit 0 or 1
- **D** = decimal digit 0 to 9
- **O** = octal digit 0 to 7
- **A** = any ASCII character
system, thus enhancing test coverage, troubleshooting, and the efficiency with which experiments are conducted.

The use of off-the-shelf commercial hardware and operating system software greatly reduced the development effort and cost of ownership.

Because of the capabilities of AIDS and its user-oriented operational features, experience to date, which has involved a complex flight development and integration project, has been excellent, with extremely high acceptance.

National Aeronautics and Space Administration
Ames Research Center
Dryden Flight Research Facility
February 3, 1982
APPENDIX A.—AIDS COMPONENTS

This appendix lists the components of AIDS.
The major computing subsystem components, which are from the Intel Corporation, are as follows:

ICS-80 KIT 640 Chassis and Power Supply (1 each)
Rack mount chassis, control panel, heavy duty power supply, four-slot card cage module, multibus backplane

SBC 614 Card Cage Modules (2 each)
Expands above kit to 12 slots capacity

SBC 80/30 Central Processor Board (1 each)
8085A CPU, 16K bytes RAM, 4K bytes PROM, serial port, 24 discrete I/O lines, interval timer, interrupt controller

SBC 116 Expansion Boards (2 each)
16K bytes RAM, 8K bytes PROM, 48 discretes I/O, serial port

SBC 724 Analog Output Boards (4 each)
Each board provides four 12-bit DAC channels, range ±10 volts

SBC 711 Analog Input Board (1 each)
Provides 16 balanced channels, range ±10 volts, 12-bit A/D

SBC 204 Floppy Diskette Controller Board (1 each)
Provides control of two single-density standard sized drives

SBC 310 High Speed Math Unit Board (1 each)
Provides 16-bit and 32-bit arithmetic, fixed and floating point

SBC 905 Universal Prototype Board (1 each)
1 Hz clock circuitry, bus timeout monitor circuit, PROM switching control logic, external interrupt termination

RMX80 Real-Time Multitasking Executive (1 each)
RMX830.LIB, BOT830.LIB, BOTUNR.LIB, DFSDIR.LIB, DIO830.LIB, DFSUNR.LIB, THI830.LIB, THO830.LIB, PLMS0.LIB

Additional components of the AIDS are as follows:

Floppy Diskette Drive Unit
Manufacturer: Data Systems Design, Inc.
Type: DSD-110-IN-2A drive unit (1 each)
DSD-CM chassis mount for rack (1 each)
Interface: Cable provided to mate with SBC-204 controller
Characteristics: Dual drives, standard sized floppy diskettes, single density IBM soft-sectored

Operator Terminal
Manufacturer: SOROC Technology
Type: IQ-120
Interface: RS-232C serial
Characteristics: 19,200 baud rate, 24 lines by 80 columns, vectored cursor capability
| Line Printer | Centronics Data Computer Corp. |
| Type:        | 306C                         |
| Interface:   | Standard Centronics parallel TTL interface |
| Characteristics: | 5 X 7 dot matrix, tractor feed, 80/132 character/line, 120 character/second print rate, two-channel vertical forms unit |
APPENDIX B.—AIDS REAL-TIME MULTITASKING EXECUTIVE LISTINGS

Following are printer listings generated during the building of the AIDS real-time multitasking executive firmware.
This listing shows the software components which together comprise the software system create table. It defines the initial task table, the initial exchange table, several hardware definition tables, and miscellaneous data storage area declarations.

```assembly
ISIS-IT 8000/8085 MACRO ASSEMBLER, V3.0 CONFIG PAGE 1
AIDS RMX SYSTEM CONFIGURATION MODULE 12 DEC 1979

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<th>SOURCE STATEMENT</th>
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**DISK SERVICES TASKS (6)**

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54 | ; |
55 |
56 | PUBLIC RDQBUF;RDQAB |
57 | EXTRN RQDIR;RQPATR;RQDEL;RQPFMT;RQPLX;RQPRNM |
58 | EXTRN RQDIR;RQATRX;RQDELX;RQPFMT;RQPLX;RQPRNM |
59 |

0039 44455253 60 TASK4: DB 'DIRSVC' ; DIRECTORY SERVICES
0039 5642 |
003F 0000 E 61 DB RQDIR |
0041 3A01 D 62 DB STK4 |
0043 3000 E 63 DB 48 |
0045 62 64 DB 130 |
0046 0000 E 65 DB RQDIRX |
0048 2603 D 66 DB TB4 |
004A 4545452 68 TASK5: DB 'ATTRIB' ; ATTRIBUTES
004E 4942 |
0050 0000 E 69 DB RQPATR |
0052 6A01 D 70 DB STK5 |
0054 4000 E 71 DB 64 |
0056 83 72 DB 131 |
0057 0000 E 73 DB RQATRX |
0059 3A03 D 74 DB TB5 |
005B 44454C45 76 TASK6: DB 'DELETE' |
005F 5A45 |
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0063 A001 D 78 DB STK6 |
0065 4000 E 79 DB 64 |
0067 84 80 DB 132 |
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006A 4E03 D 82 DB TB6 |
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0070 4154 |
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0074 A001 D 86 DB STK7 |
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0078 85 88 DB 133 |
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007B 2603 D 90 DB TB7 |
007D 42444444 92 TASK8: DB 'LOAD' |
0081 2020 |
0083 0000 E 93 DB RQPLD |
0085 2A02 D 94 DB STK8 |
0087 4000 E 95 DB 64 |
0089 86 96 DB 134 |
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LOC OBJ LINE SOURCE STATEMENT

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0090 00
0091 4531 156 DB 'FI'
0093 00 157 DB 0:0:1
0094 00
0095 01

0096 01 159 RD6664: DB 1 ; DRIVE CHARACTERISTICS TABLE
0097 70 160 DB 70H ; 204 BOARD I/O ADDRESS
0098 90 161 DB 0 ; CONTROLLER CHIP 0
0099 00 162 DB 8 ; TRACK STEP TIME = 8 MS
009A 08 163 DB 8 ; HEAD SETTLING TIME = 8 MS
009B 49 164 DB 49H ; INDEX COUNT = 4 , LOAD TIME = 35 MS
165
166 ; BUFFER ALLOCATION BLOCK
167
009C 0000 168 RD6668: DW 0:0 ; STATIC MODE
009D 0000
009E 02 169 DB 2 ; MAXIMUM OF 2 FILES CONCURRENTLY OPEN
009F 4E7 0 170 DW BARRAM
171
172 DSEG
173
0000 174 RL6665: DS 15 ; EXCHANGE AREA
000F 175 RL6666: DS 15
0010 176 RL6667: DS 15
0011 0 177 RL6668: DS 15
0012 0 178 RL6669: DS 15
0013 0 179 RL666A: DS 15
0014 0 180 RL666B: DS 15
0015 0 181 RL666C: DS 15
0016 0 182 RL666D: DS 15
0017 0 183 RL666E: DS 15
0018 0 184 RL666F: DS 15
0019 0 185
001A 186 ST6670: DS 80 ; STACK AREA
001B 187 ST6671: DS 36
001C 188 ST6672: DS 48
001D 189 ST6673: DS 48
001E 190 ST6674: DS 64
001F 191 ST6675: DS 64
0020 192 ST6676: DS 64
0021 193 ST6677: DS 64
0022 194 ST6678: DS 64
0023 195 ST6679: DS 64
196
0024 197 TB667A: DS 20 ; TASK DESCRIPTOR AREA
0025 198 TB667B: DS 20
0026 199 TB667C: DS 20
0027 19A TB667D: DS 20
0028 19B TB667E: DS 20
0029 19C TB667F: DS 20
002A 200 TB6680: DS 20
002B 201 TB6681: DS 20
002C 202 TB6682: DS 20
002D 203 TB6683: DS 20
002E 204 TB6684: DS 20
**PUBLIC SYMBOLS**

CNTLIX D 007B RTDBB C 000C RDQRTB C 0000 RDQST C 0004 RDQBUF D 04B2 RDQCT C 000C RDQSCA C 0006
RDQLEX D 0000 RDQLEX D 000F RDQLEX D 001E RDQLEX D 002B RDQLEX D 003C RDQLEX D 004B RDQLEX D 005A
RDQLEX D 0069 RDQNEV C 000B RDPOOL D 03B2 RDPOOL D 03B2 RREADX D 00B2 UNRITX D 00BC

**EXTERNAL SYMBOLS**

RDALRM E 0000 RDATRX E 0000 RDBOOT E 0000 RDBUG E 0000 RDBELX E 0000 RDDIRX E 0000 RDISKX E 0000
RDQGFX E 0000 RDQH4 E 0000 RQHNPX E 0000 RDQLEX E 0000 RQLEX E 0000 RDLEX E 0000 RQDLX E 0000
RDQGATR E 0000 RDQIPL E 0000 RDQPAR E 0000 RDQPSK E 0000 RDQPPET E 0000 RDQPLD E 0000 RDQPMN E 0000
RDQHMK E 0000 RDQTHI E 0000 RDQNAKE E 0000

**USER SYMBOLS**

BARRAM D 076E CNTLIX D 007B IET C 0000 ITT C 0006 RDALRM E 0000 RDATRX E 0000 RTDBB C 000C
RDQRTB C 0000 RDQST C 0004 RDQBUF D 04B2 RDQBUG E 0000 RDQCT E 000C RDQSCA E 0006
RDQLEX D 0000 RDQLEX D 000F RDQLEX D 001E RDQLEX D 002B RDQLEX D 003C RDQLEX D 004B
RDQLEX D 005A RDQLEX D 0069 RDQLEX E 0000 RDQNEV C 000B RDQOIX E 0000 RQDQTM E 0000 RDQLEEX E 0000
RDQGATR E 0000 RDQIPL E 0000 RDQPAR E 0000 RDQPSK E 0000 RDQPPET E 0000 RDQPLD E 0000 RDQPMN E 0000
RDQHMK E 0000 RDQTHI E 0000 RDQNAKE E 0000

**ASSEMBLY COMPLETE, NO ERRORS**
SUBMIT File Listing

This listing defines the sequence of operations performed by the MDS in building the firmware. The configuration module is linked with the other RTMTX modules, located at address 40H, and finally converted to a HEX file, which is used to program the PROMs.

```
LINK &
  :F1:BOT830.LIB(VECRST), &
  :F1:RMX830.LIB(START), &
  :F1:RMX830.LIB(SUSPND,RESUME,DLTASK,DLEXCH), &
  :F1:CONFIG.OBJ, &
  :F1:BOT830.LIB, &
  :F1:DFSDIR.LIB(SEEK,DIRECTORY,ATTRIB,DELETE,RENAM,ELOAD), &
  :F1:DFSDIR.LIB(FORMAT,FORMAT201,FMTTABLE), &
  :F1:DI0830.LIB, &
  :F1:DFSUNR.LIB, &
  :F1:THI830.LIB, &
  :F1:TH0830.LIB, &
  :F1:RMX830.LIB, &
  :F1:BOTUNR.LIB, &
  :F1:PLM80.LIB &
    TO &
  :F1:ROM.OBJ &
    MAP &
    PRINT(:F1:ROMLNK.LST)
LOCATE &
  :F1:ROM.OBJ &
    TO &
  :F1:ROM.ABS &
    CODE(40H) &
    STACKSIZE(0) &
    DATA(ODC00H) &
    MAP &
    PUBLICS &
    SYMBOLS &
    LINES &
    PRINT(:F1:ROMLOC.LST)
ATTRIB :F1:ROM.HEX W0
DELETE :F1:ROM.HEX
OBJHEX :F1:ROM.ABS TO :F1:ROM.HEX
ATTRIB :F1:ROM.HEX W1
COPY :F1:ROMLNK.LST TO :LP:
COPY :F1:NAME TO :LP:
COPY :F1:DATE TO :LP:
COPY :F1:ROMLOC.LST TO :LP:
```
Linker Listing

This listing is generated by the object linker and provides a list of all modules included.

ISIS-II OBJECT LINKER V3.0 INVOKED BY:
-INK &
** :F1:BOT830.LIB(VECRST), &
** :F1:RMX830.LIB(START), &
** :F1:RMX830.LIB(SUSPND,RESUME,DLTASK,DLEXCH), &
** :F1:CONFIG.OBJ, &
** :F1:BOT830.LIB, &
** :F1:DFSDIR.LIB(SEEK,DIRECTORY,ATTRIB,DELETE,RENAME,LOAD), &
** :F1:DFSDIR.LIB(FORMAT,FORMAT201,FORMATABLE), &
** :F1:DFSDIR.LIB, &
** :F1:DFSDIR.LIB, &
** :F1:RMX830.LIB, &
** :F1:RMX830.LIB, &
** :F1:RMX830.LIB, &
** :F1:RMX830.LIB, &
** :F1:RMX830,LIB (RESUME), &
** :F1:RMX830,LIB (DITASK), &
** :F1:BOT830,LIB, &
** :F1:RMX830.LIB (RQBOOT), &
** :F1:RMX830.LIB (RDSECT), &
** :F1:RMX830.LIB (RQBOOT), &
** :F1:RMX830,LIB (FORMAT), &
** :F1:RMX830.LIB (FORMAT201), &
** :F1:DFSDIR,LIB (SEEK), &
** :F1:DFSDIR,LIB (DIRECTORY), &
** :F1:DFSDIR.LIB (ATTRIB), &
** :F1:DFSDIR.LIB (DELETE), &
** :F1:DFSDIR.LIB (RENAME), &
** :F1:DFSDIR.LIB (LOAD), &
** :F1:DFSDIR.LIB (FORMAT), &
** :F1:DFSDIR.LIB (FORMAT201), &

LINK MAP OF MODULE ROM
WRITTEN TO FILE :F1:ROM.OBJ
MODULE IS A MAIN MODULE

SEGMENT INFORMATION:
START STOP LENGTH REL NAME

<table>
<thead>
<tr>
<th>Segment</th>
<th>Start</th>
<th>Stop</th>
<th>Length</th>
<th>Rel</th>
<th>Name</th>
</tr>
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<tr>
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<td>3EFBH</td>
<td>B</td>
<td>CODE</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>DATA</td>
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<td></td>
</tr>
<tr>
<td>STACK</td>
<td></td>
<td></td>
<td>STACK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0000H</td>
<td>0002H</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
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</tr>
<tr>
<td>0008H</td>
<td>000AH</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>0010H</td>
<td>0012H</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>0018H</td>
<td>001AH</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>0020H</td>
<td>0022H</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>0024H</td>
<td>002EH</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>0030H</td>
<td>0032H</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>0034H</td>
<td>0036H</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>0038H</td>
<td>003AH</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
<tr>
<td>005CH</td>
<td>005EH</td>
<td>3H</td>
<td>A</td>
<td>Absolute</td>
<td></td>
</tr>
</tbody>
</table>

INPUT MODULES INCLUDED:
 :F1:BOT830.LIB(VECRST)
 :F1:RMX830.LIB(START)
 :F1:RMX830.LIB(SUSPND)
 :F1:RMX830.LIB(RESUME)
 :F1:RMX830.LIB(DLTASK)
 :F1:RMX830.LIB(DLEXCH)
 :F1:CONFIG.OBJ(CONFIG)
 :F1:BOT830.LIB(INB30P)
 :F1:BOT830.LIB(RDBO0T)
 :F1:BOT830.LIB(FILNAM)
 :F1:BOT830.LIB(RDSECT)
 :F1:DFSDIR.LIB(SEEK)
 :F1:DFSDIR.LIB(DIRECTORY)
 :F1:DFSDIR.LIB(ATTRIB)
 :F1:DFSDIR.LIB(DELETE)
 :F1:DFSDIR.LIB(RENAME)
 :F1:DFSDIR.LIB(LOAD)
 :F1:DFSDIR.LIB(FORMAT)
 :F1:DFSDIR.LIB(FORMAT201)
:FI:DFSDIR.LIB(FMTTABLE)
:FI:DI0830.LIB(DISKIO)
:FI:DI0830.LIB(HAN204)
:FI:DFSUNR.LIB(NOFORMAT202)
:FI:DFSUNR.LIB(NOFORMAT204)
:FI:DFSUNR.LIB(NOFORMAT206)
:FI:DFSUNR.LIB(DRIVETIMEOUTVAL)
:FI:DFSUNR.LIB(MINISTARTUP)
:FI:THI830.LIB(THDINI)
:FI:THI830.LIB(ECHO)
:FI:THI830.LIB(STDINF)
:FI:THI830.LIB(PRINF)
:FI:THI830.LIB(SCANBAUDRATE)
:FI:THI830.LIB(LNEDIT)
:FI:THI830.LIB(THDING)
:FI:THI830.LIB(CONTROL)
:FI:THI830.LIB(USART8030)
:FI:THI830.LIB(CNTRLTABLE)
:FI:THI830.LIB(MERGER)
:FI:RMX830.LIB(SYNSH)
:FI:RMX830.LIB(RBYLST)
:FI:RMX830.LIB(DLYLST)
:FI:RMX830.LIB(DJMAN)
:FI:RMX830.LIB(SL)
:FI:RMX830.LIB(RMVSSL)
:FI:RMX830.LIB(ENTSLL)
:FI:RMX830.LIB(TB0030)
:FI:BOTUNR.LIB(THRATE)
:FI:BOTUNR.LIB(RESETV)
:FI:BOTUNR.LIB(NODBGR)
:FI:BOTUNR.LIB(FILUNR)
:FI:PLM80.LIB(0P0011)
:FI:PLM80.LIB(0P0014)
:FI:PLM80.LIB(0P0018)
:FI:PLM80.LIB(0P0025)
:FI:PLM80.LIB(0P0029)
:FI:PLM80.LIB(0P0034)
:FI:PLM80.LIB(0P0086)
:FI:PLM80.LIB(0P0091)
:FI:PLM80.LIB(0P0094)
:FI:PLM80.LIB(0P0096)
:FI:PLM80.LIB(0P0098)
:FI:PLM80.LIB(0P0101)
:FI:PLM80.LIB(0P0103)
Locator Listing

This listing is generated by the object locator and provides a complete list of all PUBLIC symbols.

ISIS-II OBJECT LOCATER V3.0 INVOKED BY:
-LOCATE &
** :F1:ROM.OBJ &
** TO &
** :F1:ROM.ABS &
** CODE(40H) &
** STACKSIZE(0) &
** DATA(0DC00H) &
** MAP &
** PUBLICS &
** SYMBOLS &
** LINES &
** PRINT(:F1:ROMLOC.LST)

SYMBOL TABLE OF MODULE ROM
READ FROM FILE :F1:ROM.OBJ
WRITTEN TO FILE :F1:ROM.ABS

VALUE TYPE SYMBOL

0000H PUB R?VECRST
0040H PUB R?BRSTR
00C1H PUB R?RSUSP
00EFH PUB R?RESM
011DH PUB R?RDTSK
0166H PUB R?ROXCH
0271H PUB R?RBAB
0185H PUB R?RCRTB
0259H PUB R?RCST
0261H PUB R?RDOC
0268H PUB R?RDR4
0269H PUB R?RDEV
044EH PUB R?INTDI
03FFH PUB R?INTEI
037FH PUB R?INTINI
03E7H PUB R?LMASK
0443H PUB R?RDLVL
0448H PUB R?RELVL
0285H PUB R?RONDI
0469H PUB R?ROSETV
02F3H PUB R?UDPRI
0483H PUB R?ROBOOT
0615H PUB R?BUTSTR
061EH PUB R?ROSECT
0674H PUB R?RISEEK
0A8AH PUB R?DETBLK
1095H PUB R?RLSMAP
0A80H PUB R?MAPDBP
159DH PUB R?FILEOPENCHECK
188AH PUB R????DEL
1CE1H PUB R?RFDFN
1071H PUB R?RTDIR
1382H PUB R?RJJDFN
109FH PUB R?RRTFCB
160BH PUB R?VALIDATEREQUEST
1282H PUB R?RPREAD
149CH PUB R?FILENAMECHECK
123BH PUB R?RPRTSK
107EH PUB R?RFILEDIR
0E2BH PUB R?RIRGET
0C2BH PUB R?RIFREKB
1283H PUB R?RDSAVE
0A0BH PUB R?RABS10
3B4EH PUB R?ENTDLY
3C55H PUB R?STPDLY
3D99H PUB R?OBJJNI
3D6EH PUB RQCTS
3D75H PUB ROXCH
3C55H PUB R?SETUP
3D88H PUB R?ENTSUS
3C22H PUB R?RMVVSUS
3DCCH PUB R?RMVL
3E5FH PUB R?ENTSULL
3E31H PUB R???TICK
3E5EH PUB R?STRCCL
3E64H PUB R?STPCCL
3E6AH PUB R?TCKIN
3E77H PUB R?RAT
3E79H PUB R?RSTSHD
3E7CH PUB RQFILE
3E85H PUB @0011
3E87H PUB @0012
3E88H PUB @0013
3E92H PUB @0014
3E93H PUB @0015
3E96H PUB @0016
3E97H PUB @0017
3E98H PUB @0018
3E99H PUB @0019
3E9AH PUB @0020
3EAAH PUB @0021
3EADH PUB @0022
3EAEA PUB @0023
3EB6H PUB @0030
3ED5H PUB @0034
3ED7H PUB @0035
3EE9H PUB @0066
3EECH PUB @0087
3EEDH PUB @0088
3EF3H PUB @0091
3EF6H PUB @0092
3EF7H PUB @0093
3F03H PUB @0094
3F06H PUB @0095
3F09H PUB @0096
3F10H PUB @0097
3F17H PUB @0098
3F19H PUB @0099
3F19H PUB @00100
3F24H PUB @00101
3F27H PUB @00102
3F2FH PUB @00103
3F32H PUB @00104
3C00H PUB RORSTV
3C48H PUB CNTL1X
E122H PUB RQDRUF
D67OH PUB RQLOEX
D67FHD PUB RQL2EX
D6BEH PUB RQL3EX
D6DH PUB RQL4EX
D6ACH PUB RQL5EX
D6BH PUB RQLAX
D6CAH PUB RQLBEX
D6C9H PUB RQLCEX
E022H PUB RQPOOL
DCF2H PUB UREADX
DCFCH PUB UWRITX
E753H PUB R?ADRXCH
E751H PUB R?INITM
E73FH PUB R?SIMVEC
E769H PUB R?RESPFX
E75FH PUB R?BOTX
E755H PUB R?LOGDX
E775H PUB R?SLPMGS
E77EH PUB R?RNAME
E766H PUB R?CLSKIL
E772H PUB R?FREEBUFCH
E932H PUB R?OFNX
E76CH PUB R?OIRX
E7F0H PUB R?FBLORG
E8EFH PUB R?FCBLISTLOCK
E903H PUB R?BITMAPLOCK
E7FCH PUB R?RETURNBUFCH
EB09H PUB R?DISDISKSTD
E8F9H PUB R?DIRETCWORK
E90AH PUB R?ABS10M
E900H PUB R?OATRX
E9C0H PUB R?QDELX
E9E1H PUB R?R3NAVX
EA09H PUB R?QLDX
EA48H PUB R?QMTX
EA79H PUB R?ENTX1
EA7CH PUB R?Q6SKX
EA7AH PUB R?ENT204
EA95H PUB R?QIPNX
EA9FCH PUB R?QOWAKE
EAA0H PUB R?Q6EX
EA90H PUB R?QBUG
EAC2H PUB R?LINES
EACH PUB R?LINESS
EA68H PUB R?CHASS
EAE0H PUB R?CHARINPEXC
EAE9H PUB R?ECHOEXC
ED6DH PUB R?ALARMSS
ED77H PUB R?CNTRL
ED81H PUB R?OUTX
ED88H PUB R?ALARM
ED95H PUB R?EXIT
EE08H PUB R??2RLR
EE0BH PUB R?OACTV
EE24H PUB R??2OLH
EE36H PUB R?OILEX
EE60H PUB R??2ELR
EE4AH PUB R??2LRL
EE6CH PUB R??2SLR

MEMORY MAP OF MODULE ROM
READ FROM FILE :FI:ROM.OBJ
WRITTEN TO FILE :FI:ROM.ABS
MODULE START ADDRESS 0040H

<table>
<thead>
<tr>
<th>START</th>
<th>STOP</th>
<th>LENGTH</th>
<th>REL NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000H</td>
<td>002AH</td>
<td>3H</td>
<td>A ABSOLUTE</td>
</tr>
<tr>
<td>0008H</td>
<td>00A8H</td>
<td>3H</td>
<td>A ABSOLUTE</td>
</tr>
<tr>
<td>0010H</td>
<td>0012H</td>
<td>3H</td>
<td>A ABSOLUTE</td>
</tr>
<tr>
<td>0018H</td>
<td>001AH</td>
<td>3H</td>
<td>A ABSOLUTE</td>
</tr>
<tr>
<td>0020H</td>
<td>0022H</td>
<td>3H</td>
<td>A ABSOLUTE</td>
</tr>
<tr>
<td>0024H</td>
<td>0026H</td>
<td>3H</td>
<td>A ABSOLUTE</td>
</tr>
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<td>0032H</td>
<td>3H</td>
<td>A ABSOLUTE</td>
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<td>0036H</td>
<td>3H</td>
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</tr>
<tr>
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<td>003AH</td>
<td>3H</td>
<td>A ABSOLUTE</td>
</tr>
<tr>
<td>003CH</td>
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</tr>
<tr>
<td>0040H</td>
<td>3F3AH</td>
<td>3E8FH</td>
<td>B CODE</td>
</tr>
<tr>
<td>DC00H</td>
<td>EE74H</td>
<td>1275H</td>
<td>B DATA</td>
</tr>
<tr>
<td>EE75H</td>
<td>F68FH</td>
<td>848BH</td>
<td>B MEMORY</td>
</tr>
</tbody>
</table>
APPENDIX C.—TYPICAL HiMAT DISPLAYS

This appendix describes some of the displays used in the HiMAT program.
Command Interpreter Display

This is the display to which the AIDS executive returns when the user has terminated the previous operation. This display provides the operator with the following information: (1) the version of the AIDS executive, (2) the name and version number of the user module, (3) a list of the available user commands, and (4) a list of the available system commands. The operator enters the desired command, and the corresponding overlay is loaded and executed. A special case is the command "LD" which is used to activate the displays stored on the scratch diskette: (1) the scratch diskette directory is examined to determine the page number of the file specified, (2) the corresponding overlay is loaded, (3) the display templates are copied from the scratch diskette file into the overlay, and (4) the display is activated in refreshed mode.

Hard copy of the HiMAT command interpreter display:

AIRCRAFT INTERROGATION & DISPLAY SYSTEM

AIDS-II SYSTEM EXECUTIVE  16 SEPT 1980  R GLOYER

USER LOAD MODULE NAME : HIMAT 8.15.8B

USER COMMANDS :
  FF  MP  MC  MD  MT  TX
  A1  A2  A3

SYSTEM COMMANDS :
  IC  TC  PC  DK  LD  FD
  S1O  SMP  SMS  SMD  SMF

Scratch Diskette Directory Display

This display is generated by the AIDS executive in response to a "DK" command. It shows the name of the scratch diskette currently in drive number 1 and lists the contents of each of the 45 available files. The operator has a menu of commands to choose from:

LD    = load a file and present the display in refreshed mode
SAVE  = write the current overlay display into a selected file
INIT  = initialize a new scratch diskette with selected name
DEL   = delete a selected file
NAME  = rename a selected file
Hard copy of typical HiMAT scratch diskette directory:

<table>
<thead>
<tr>
<th>FILE</th>
<th>PAGE</th>
<th>DESCRIPTION</th>
<th>FILE</th>
<th>PAGE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>RATE GYROS</td>
<td>16</td>
<td>3</td>
<td>D/L ST. ADS</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>ACCELS</td>
<td>17</td>
<td>1</td>
<td>BLS/W'S</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>PRESSURES</td>
<td>18</td>
<td>3</td>
<td>KEMPEL 3A</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>SURFACES</td>
<td>19</td>
<td>3</td>
<td>KEMPEL 3B</td>
</tr>
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<td>5</td>
<td>3</td>
<td>RADAR ALT</td>
<td>20</td>
<td>3</td>
<td>KEMPEL 3C</td>
</tr>
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<td>6</td>
<td>3</td>
<td>ATITUDES</td>
<td>21</td>
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</tr>
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<td>2</td>
<td>KEMPEL 1</td>
<td>22</td>
<td>3</td>
<td>D/L TEST</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>DUPACTS LC</td>
<td>23</td>
<td>3</td>
<td>ENG TEST</td>
</tr>
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<td>9</td>
<td>2</td>
<td>LIMC/V/0</td>
<td>24</td>
<td>3</td>
<td>4 P MCH</td>
</tr>
<tr>
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<td>3</td>
<td>SURF CALIB</td>
<td>25</td>
<td>3</td>
<td>ENG TEST</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>DIV COMB</td>
<td>26</td>
<td>3</td>
<td>3 POWER SUP</td>
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<td>12</td>
<td>3</td>
<td>PAN U/L</td>
<td>27</td>
<td>3</td>
<td>5 C FAIL</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>KEMPEL 2</td>
<td>28</td>
<td>3</td>
<td>3 C FAIL</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>D/L ACT FLS</td>
<td>29</td>
<td>3</td>
<td>3 C FAIL</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>DUP ACT FL</td>
<td>30</td>
<td>3</td>
<td>1 TRUTH</td>
</tr>
</tbody>
</table>

Command list: LD SAVE INIT DEL NAME

Tabular Data Display

This display is accessed by the user command "MP" and allows the user to define a display of up to 20 data items. For each item the user must specify item number, data type, hexadecimal address, description, and units. In addition, if the data type is either F1 or F2, the operator must also enter the zero and maximum scaling of the parameter in engineering units. Once created, the display may be saved on the scratch diskette if desired.

Hard copy of typical HiMAT page 3 display:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>TYPE</th>
<th>ADDR</th>
<th>ZERO (EU)</th>
<th>MAX (EU)</th>
<th>DESCRIPTION</th>
<th>VALUE</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VG</td>
<td>6125</td>
<td>PITCH</td>
<td>158.798</td>
<td>DEGREES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>VG</td>
<td>6131</td>
<td>ROLL</td>
<td>148.776</td>
<td>DEGREES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>DG</td>
<td>618A</td>
<td>YAW</td>
<td>331.260</td>
<td>DEGREES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>EO</td>
<td>6131</td>
<td>90 D ROLL</td>
<td>000.000</td>
<td>ZERO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>DV</td>
<td>6290</td>
<td>SPECIAL OP</td>
<td>-0.620</td>
<td>VOLTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>E1</td>
<td>6109</td>
<td>UMB NOT SE</td>
<td>ONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>E3</td>
<td>610C</td>
<td>LAN NOT SE</td>
<td>ONE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>F2</td>
<td>6994</td>
<td>0.000</td>
<td>100.000</td>
<td>MIDV PR</td>
<td>0.008</td>
<td>DEG/SEC</td>
</tr>
<tr>
<td>16</td>
<td>F2</td>
<td>6995</td>
<td>0.000</td>
<td>100.000</td>
<td>MIDV VR</td>
<td>-0.049</td>
<td>DEG/SEC</td>
</tr>
<tr>
<td>17</td>
<td>EO</td>
<td>6107</td>
<td>FAST ERECT</td>
<td>ZERO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>E4</td>
<td>6108</td>
<td>PRI MODE</td>
<td>ZERO</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Disk: HiMAT G. P. 1  File No. 6  File Name: Attitudes
Block Memory Dump Data Display

This page format is accessed by command "MD" and allows the operator to display in hexadecimal format up to 304 bytes in a single block. The operator must specify the beginning and ending addresses of the block. The display may be saved on scratch diskette file if desired.

Hard copy of typical HiMAT block memory dump display:

```
OPERATE
HIMAT 8.15.08

PAGE 5  MEMORY DUMP

81D7 40 00 00 00 33 00 00 C7 30 00 01 00 00 00 00 00
81E7 92 04 00 00 88 00 01 00 00 00 00 00 48 48 00 00
81F7 80 4D 11 00 80 00 E0 00 40 00 06 00 1C 40 00

09:23:00
7.27.81

DISK : HIMAT G. P. 1  FILE NO. 42  FILE NAME : C FAIL 1
```

Free-Form Data Display

This display mode is accessed by the user command "FF" and allows the operator to create unstructured displays in any format desired. Separate commands are available to allow creating the static or background portion of the display, followed by the insertion of data items in any desired format at any location of the screen. Once created, the display may be saved on scratch diskette if desired.
Hard copy of typical HiMAT free-form data display:

OPERATE   PAGE 1
HIMAT 8.15.80
ENGINE PANEL

14.422 (PSI).

COMPRESSOR
DISCHARGE
PRESSURE

PLAD = 15.000 DEG
PLAC = 0.000 DEG

18.000 (%)  0.000 (C)  99.996 (%)  0.000 (DEG)

RPM
EXHAUST
GAS

THROTTLE
NOZZLE
POSITION

TEMPERATURE
AREA

CONTROL
ENGINE
NOZZLE

MODE
STABILITY
CONTROL

IGNITION
COMBAT
HIGH
OVERLIDE

ZERO
ZERO
ZERO
ZERO

DISK : HIMAT G. P. 1  FILE NO. 31  FILE NAME : ENG PANEL

REFERENCES


A microprocessor-based general purpose ground support equipment for electronic systems has been developed and placed in service at the NASA Dryden Flight Research Facility. The hardware and software are designed to permit diverse applications in support of aircraft flight systems and simulation facilities. This paper describes the implementation of the hardware and the structure of the software and describes the application of the system to an ongoing research aircraft project.