ADVANCED AIRBORNE TEST INSTRUMENTATION SYSTEM (AATIS) PROGRAM SYSTEM OVERVIEW

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ABSTRACT

The Advanced Airborne Test Instrumentation System (AATIS), one of the major instrumentation systems in use today by the Department of Defense (DoD), was developed in the late 1980's to improve and modernize its predecessor - the Airborne Test Instrumentation System (ATIS). Use of AATIS, by not only the Air Force but the Navy and Army, has improved instrumentation commonality and interoperability across multiple test programs. AATIS, developed by the same manufacturer as the DoD Common Airborne Instrumentation System (CAIS), has a common bus structure - enabling cross utilization of many components which will ease transition from one system to another.

The objective of this paper is to provide an overview on the Advanced ATIS System and its logistics support concept. For system description, an overview is presented on the airborne system and related ground support equipment. A brief description is given on the three levels of maintenance being used or planned for by the using activities. Finally, a projection is presented on the utilization of this system for the next 3 years.

KEY WORDS

Airborne Instrumentation, Signal Conditioning Modules

INTRODUCTION

The Advanced ATIS predecessor, ATIS, was originally developed in the early 1970s as the standard flight test instrumentation system for the Air Force Flight Test Center (AFFTC). The system has been utilized to support a broad range of aircraft development and qualification tests at AFFTC and elsewhere since 1974. The ATIS system is currently installed in about 60 test aircraft.

Aircraft currently being equipped with AATIS data acquisition systems include F-15 and F-16 test aircraft stationed at Eglin AFB, Florida and Edwards AFB, California. In addition, two B1-B bombers, several Army helicopters, and a research aircraft from NASA/Langley are also being instrumented with the system. It is expected that at least 20 test air vehicles will be installed with the AATIS system within the next 3 years.

SYSTEM OVERVIEW

AATIS is a general-purpose flight test data acquisition system consisting of an integrated family of modular airborne components and related ground support equipment (Figure 1). The airborne acquisition or airborne equipment can be tailored in size, capability, and cost to meet individual test program requirements. The ground support segment is composed of a set of support equipment, which enables the users to (1) generate formats, (2) load/verify airborne units, and (3) perform acceptance tests and system-level diagnostics. Other airborne instrumentation elements not considered part of the Advanced ATIS system are transducers, airborne recorders, encryption devices, and transmitters.

AIRBORNE SYSTEM

System Controller III (SCU3):

The System Control Unit III (SCU3) is the primary system controller for the Advanced ATIS. It's principal function is to provide command and control of it data acquisition units. The controller retrieves data from the remote units and merges the data into serial PCM outputs for on-board recording or encryption and telemetry. SCU3 can operate with a data rate selectable from 2,500 bits per second (bps) to 5 megabits per second (Mbps). Other technical characteristics are tabulated in the Appendix.

Analog Data Acquisition Units:

The Analog Data Acquisition Unit (ADAU) is a modular component of the AATIS system. The ADAU operates only as a remote unit, acquiring data from both analog and digital input sources for the controller. In addition to the 32 direct analog inputs, the unit provides 6 signal conditioning card slots that are user selectable as to the type of signal conditioners installed.

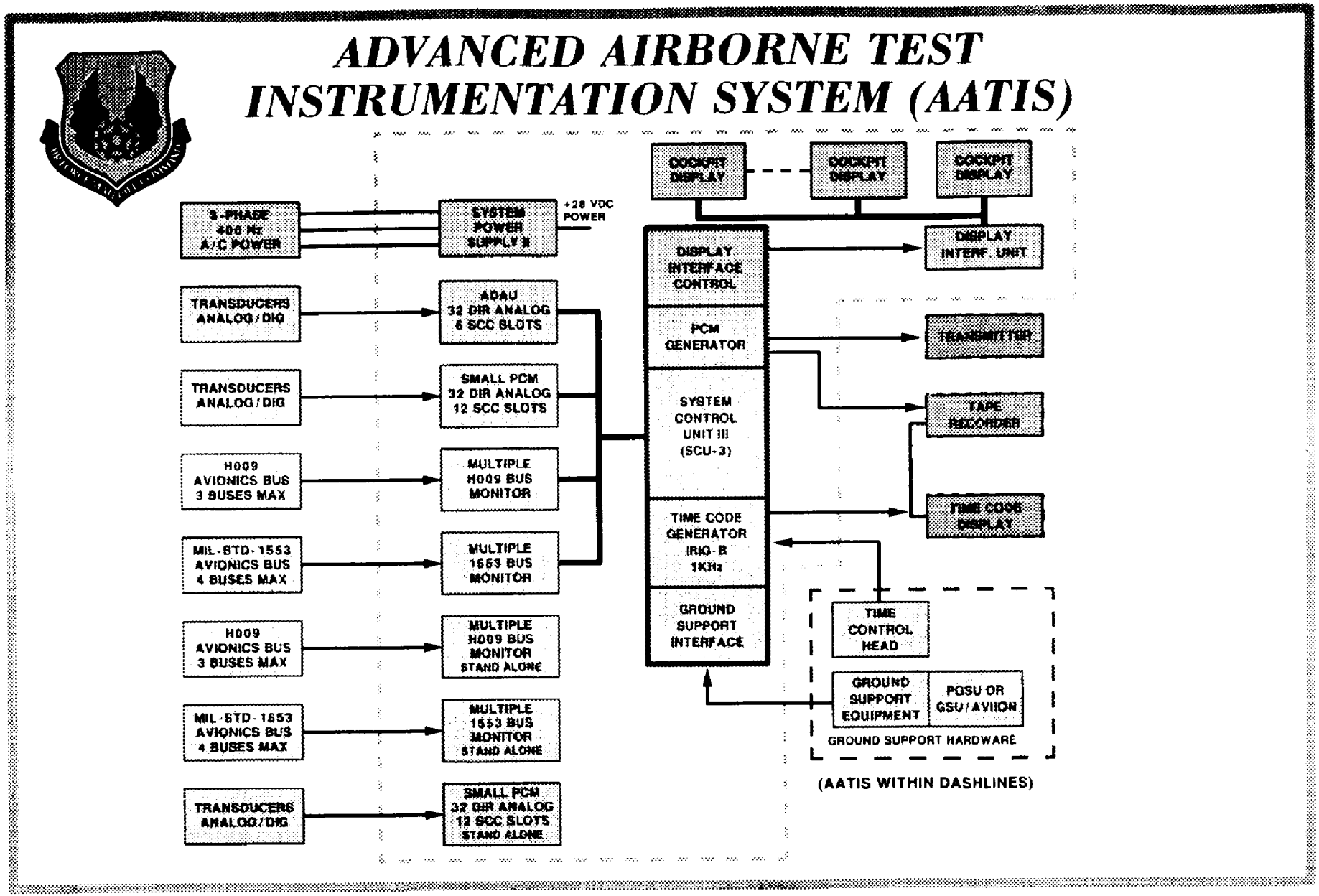
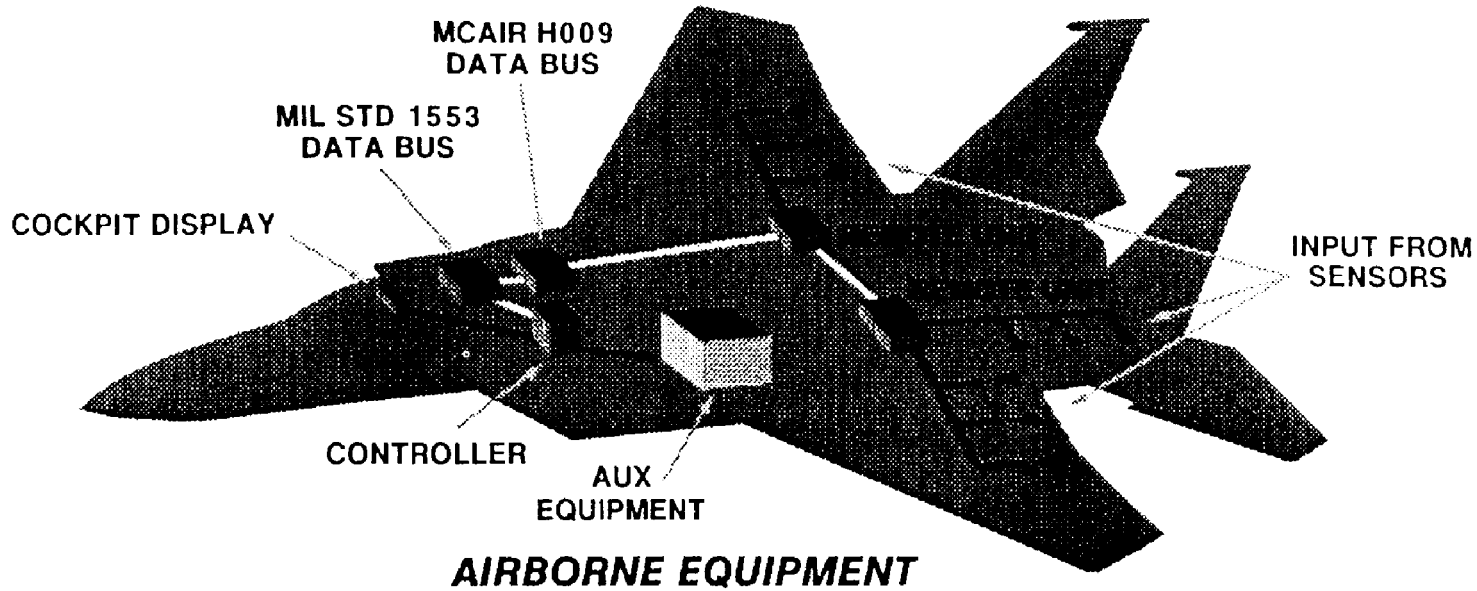


FIGURE 1a ADVANCED ATIS FUNCTIONAL BLOCK DIAGRAM

ADVANCED AIRBORNE TEST INSTRUMENTATION SYSTEM (AATIS)



AIRBORNE EQUIPMENT

GROUND SUPPORT EQUIPMENT

FIGURE 1b AIRBORNE SYSTEM AND GROUND SUPPORT EQUIPMENT

The Small Pulse Code Modulation System (SPCM) is a more versatile data acquisition unit than the ADAU. In addition to being used as a remote unit, it can operate in either a stand-alone mode or as a controller to Advanced ATIS avionics data acquisition units. There are 12 signal conditioning card slots within the unit for customizing system configuration.

Avionics Data Acquisition Units:

The Multiple Data Bus Monitor (MDBM) is a bus monitor capable of monitoring up to four dual redundant MIL-STD-1553 avionics buses; the output PCM bit rate is programmable up to 8.0 Mbps. The system users can configure the MDBM in any of the three configurations: (1) remote unit to the SCU3 controller, (2) remote unit to the SPCM controller or (3) stand-alone mode. While in the stand-alone configuration, the MDBM can operate in three modes: (1) 100 percent bus monitor in accordance with *IRIG 106, (2) user programmable subset of the 100 percent bus traffic, and (3) user programmable bus monitor, outputting up to 4,000 different bus words.

The Multiple H009 Data Bus Monitor (MHBM) is a bus monitor design to monitor both H009 and 1553 avionics bus traffic. The basic unit monitors one dual redundant MIL-STD-1553 bus; up to three additional MIL-STD-1553 or H009 avionics buses may be monitored with add-on interface modules. Like the MDBM, the output PCM bit rate is programmable up to 8.0 Mbps. The system users can configure the MHBM in any of the three configurations: (1) remote unit to the SCU3 controller, (2) remote unit to the SPCM controller, or (3) in stand-alone mode. While in the stand-alone configuration, the MHBM can operate in two modes: (1) 100 percent bus monitor in accordance with *IRIG 106, or (2) user programmable bus monitor, outputting up to 4,000 different bus words.

Signal Conditioning Modules:

The following are a list of advanced ATIS signal conditioners that can be used interchangeably in either the SPCM or the ADAU:

Signal Conditioner	Channels/ Card	Brief Description
Analog Attenuator	8	Attenuates signals >+10V ;8 programmable gain values.
Analog Data Filters (3 types)	4	Lowpass, 6-pole filters
Control Signal Generator	4	4 on/off control signals
Event Time Recorder	7	One event per channel

* As a 100 percent bus monitor, the MDBM and MHBM were designed in 1989-1990 based on IRIG 106 Chapter 8 extension, preliminary edition.

Freq Converter/Pulse Totalizer	4	Input freq. range 5Hz to 50KHz; for flow transducers/tach gen.
Parallel Digital Module	16 BITS	Accepts 16 bits as one word.
Phase Sensitive Demodulator	3	Conditions outputs of LVDT type transducers.
Resist Temp Sensor Cond (2 types)	4,8	Conditions outputs of resistive temperature devices.
Serial Digital Conditioner	4	Accepts serial data streams of up to 30 bits.
Synchro/Resolver Converter	2	Programmable for either synchro or resolver signal sources.
Transducer Excitation Supply	8	For bridge/potentiometer transducers; voltage levels 2.5, 5, 10 volts DC.

GROUND SUPPORT EQUIPMENT

The Advanced ATIS system includes a complement of ground support and special test equipment, which provides for flight support and depot maintenance of AATIS units. Currently, AFFTC is developing a set of ground support equipment (GSE) and complementary software called Test Instrumentation Management System (TIMS) to support ATIS, AATIS, Common Airborne Instrumentation Systems (CAIS) , and other flight data acquisition systems. The TIMS Ground Support Unit provides the users with more comprehensive and sophisticated functions than the AATIS Portable Ground Support Unit.

The TIMS hardware and software functionality can be hosted on a rackmount server for laboratory use or installation in a mobile flightline cart. Other TIMS GSE include a deskside workstation, a "rollaround" portable unit, and a laptop PC-based unit. Detailed capabilities of TIMS GSE are described in a separate technical paper to be presented at the 1993 International Telemetering Conference (ITC).

The following is a brief description of the Advanced ATIS Ground Support and Special Test Equipment provided by the AATIS manufacturer:

Portable Ground Support Unit:

The PGSU is a 386/486 PC-based unit to support preflight and postflight operations. The PGSU functions include (1) build and edit memory formats of an airborne component, (2) memory load and verify, (3) decommutate PCM output from an airborne component, (4) display of selected PCM data in raw or engineering units, and (5) print memory format or PCM data.

PCM Recombiner:

The PCM Recombiner is to be used to recombine, from a tape reproducer output, all recorded dedicated secondary tracks (from the SCU3, MDBM or MHBM) into a composite bit stream for data reduction and analysis.

Special Test Equipment:

The Advanced ATIS Test Set (AATS) performs acceptance tests and system-level diagnostics for SCU3, ADAU, SPCM, MDBM, and MHBM. The test set is a PC-based unit that contains a common set of test stimulus cards inserted in the computer's expansion slots. By connecting the appropriate adapter chassis and unit specific test equipment, the test set is configured to run the Acceptance Test Procedure (ATP) for an airborne component.

The Multiple H009/1553 Bus Simulator (MHBAS) is a menu-driven, PC-based simulator, capable of simultaneously generating McAir H009 or MIL-STD-1553 bus data on up to four dual redundant buses.

LOGISTICS SUPPORT

Similar to its predecessor, the Advanced ATIS is being supported with a three-level maintenance concept: (1) organizational (2) intermediate, and (3) depot levels. A brief description of each level is presented as follows:

1. Organizational-Level Maintenance.

This includes all maintenance tasks which must be accomplished with the flight instrumentation system installed in the test air vehicle. Maintenance tasks to be performed at the test air vehicle are:

a. System preflight and postflight checkout.
b. Fault detection/isolation to the line-replacement-unit (LRU) level.
c. On-board calibration.
d. Operational format software support.
e. LRU removal/replacement.

2. Intermediate-Level Maintenance.

The tasks that may be accomplished at the intermediate level will be determined by each using activity, based on test program requirements. Typically, these maintenance tasks include:

a. Fault detection/isolation to the shop-replacement-unit (SRU) level.
b. LRU/SRU acceptance testing.
c. Software support
d. System integration and checkout.
e. SRU removal and/or replacement.

To implement configuration and maintenance quality control, each using activity performing repair at or below LRU assembly level must submit a Quality Control Plan to the ATIS Program Office (Edwards AFB, CA) for approval.

3. Depot-Level Maintenance.

The Program Manager is responsible for depot-level maintenance of all Advanced ATIS components and related ground support equipment. A 5-year depot maintenance contract is in place with the AATIS manufacturer to provide:

a. Repair and retrofit of all Advanced ATIS LRU/SRU components and related GSE.
b. Training and field engineering support.
c. LRU/SRU and special support equipment acceptance test.
d. System configuration data base maintenance.
e. Technical manuals and data.

PROJECTED UTILIZATION OF ADVANCED ATIS

Currently, four Edwards and four Eglin test aircraft are being equipped with the instrumentation system. NASA/Langley is in the process of instrumenting a research aircraft with Advanced ATIS. Several Army helicopters are scheduled to install the system. We expect to equip at least 20 test air vehicles within the next 3 years. Once the CAIS system is developed and becomes fully operational, the procurement of Advanced ATIS components will probably cease. However, maintenance and support of the existing installed Advanced ATIS systems in test aircraft and helicopter will be required for many more years.

CAIS is being designed such that AATIS units are compatible with the bus structure. Therefore, AATIS units may be used in CAIS applications. Existing AATIS units in the field and those to be procured during the next few years will continue to be usable.

APPENDIX

ADVANCED ATIS
Technical Characteristics

System Control Unit III (SCU3):

Controls up to 63 data acquisition units.
8 user-selectable formats
30 user-selectable bit rates, 2.5 Kbps to 5 Mbps.
PCM word length: 10/12/14/16 bits.
Internal virtual processor for on-board computation.
PCM output in Bi-Phase, NRZL, and randomized NRZ.
Two programmable secondary PCM outputs.
-55 Deg C to +71 Deg C operation.

Analog Data Acquisition Unit (ADAU):

Operates as remote unit to SCU3.
32 Differential analog inputs.
6 signal conditioning card slots.
Sampling rates up to 417 K samples/second.
16 selectable gain settings (1 to 1000).
-55 Deg C to +85 Deg C operation.

Small PCM System (SPCM):

Operates as a remote unit to SCU3 or as controller to MDBM/MHBM.
32 Differential analog inputs.
12 signal conditioning card slots.
Sampling rates up to 417 K samples/second.
16 selectable gain setting (1 to 1,000).
-55 Deg C to +8 5 Deg C operation.

Multiple Data Bus Monitor (MDBM):

Output PCM bit rate programmable up to 8.0 Mbps.
PCM Outputs of NRZ, RNRZ and Bi-Phase.
Monitors up to four dual redundant 1553 Avionics Buses
Captures all or selected traffic.
Provides decommutated output of up to 4,000 different bus words.
Format memory programmable over a 56 Kbps synchronous data link.
-55 Deg C to +85 Deg C operation.

Multiple H009 Data Bus Monitor (MHBM):

Output PCM bit rate programmable up to 8. 0 Mbps.
PCM Outputs of NRZ, RNRZ, and Bi-Phase.
Monitors up to four dual redundant 1553 Avionics Buses; or three H009 buses and one 1553 bus; or two H009 buses and two 1553 buses.
Captures all or selected traffic.
Provides decommutated output of up to 4,000 different bus words
Format memory programmable over a 56 Kbps synchronous data link.
-55 Deg C to +85 Deg C operation.