"CAIS GROUND SUPPORT EQUIPMENT USING A LOW COST, PC-BASED PLATFORM"

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ABSTRACT

The Common Airborne Instrumentation System (CAIS) was developed under the auspices of the Department of Defense to promote standardization, commonality, and interoperability among flight test instrumentation. The central characteristic of CAIS is a common suite of equipment used across service boundaries and in many airframe and weapon systems.

The CAIS system has many advanced capabilities which must be tested during ground support and system test. There is a need for a common set of low cost, highly capable ground support hardware and software tools to facilitate these tasks.

The ground support system should combine commonly available PC-based telemetry tools with unique devices needed for CAIS applications (such as CAIS Bus Emulator, CAIS Hardware Simulator, etc.). An integrated software suite is imperative to support this equipment.

A CAIS Ground Support Unit (GSU) has been developed to promote these CAIS goals. This paper presents the capabilities and features of a PC-based CAIS GSU, emphasizing those features that are unique to CAIS. Hardware tools developed to provide CAIS Bus Emulation and CAIS Hardware Simulation are also described.

KEY WORDS

Key Words: Common Airborne Instrumentation System (CAIS), Ground Support Unit (GSU), PC Platform, Airborne System Controller (ASC), Data Acquisition Unit (DAU), Pulse Code Modulation (PCM).

INTRODUCTION

The Department of Defense (DOD), Office of Test and Evaluation (OTE) of the U.S. Government led the effort to develop the Common Airborne Instrumentation System. This system is predicated upon designing and building a high speed advanced suite of data acquisition equipment which will meet the majority of U.S. Navy, Airforce and Army test programs. The CAIS system provides standardization, commonality, and interoperability among flight test instrumentation.

Operation, test and maintenance of the CAIS system requires specialized hardware and software tools. Traditionally, a checkout cart or van would be stocked with bit synchronizers, decommutators, time code readers and generators, MIL-STD-1553 simulators, and possibly strip chart recorders to support the instrumentation system. "True" system testing could only be done by a few specially trained engineers using specially designed diagnostic tools. This causes a system to lack flexibility, maintainability, and serviceability. The goal of the Ground Support Unit was to eliminate an entire host of telemetry support equipment and provide simple-to-use system diagnostics and support tools. This set the stage for a better approach using the low-cost, open-architecture of the Personal Computer (PC).

DEVELOPMENT APPROACH

Hardware Platform

The CAIS GSU has been developed using the latest PC-based technology. The approach integrates the latest computer platform with low-cost, commercially-available, PC-based telemetry tools and software. The basic system is then supplemented with unique hardware and software as required to support unique CAIS applications. The result is an architecture which can be tailored to specific CAIS applications but avoids the high cost and long schedules typically encountered with ground support equipment. In addition, the architecture supports growth as PC-based technology improves.

Unique CAIS Requirements

Several PC-based cards were developed to support unique CAIS requirements. These cards include such functions as CAIS Bus Emulator, CAIS Master Emulator, and CAIS DAU Simulator, with the potential for additional cards as the need arises. ISA and PCI compatibility are used in order to maintain the desired open architecture. These cards can configured to meet many a wide variety of CAIS requirements.

Integrated Support Software

An integrated Windows-based software package was developed to integrate all CAIS ground support tasks into a single environment. This approach makes it possible to maintain flexibility, and to support "add-on" and "plug-and-play" capabilities, and gives the software "multitasking capability."

A TYPICAL CAIS CONFIGURATION

F-22 Advanced Tactical Fighter

The GSU was developed for the F-22 Advanced Tactical Fighter. This is a new aircraft which is required to be heavily instrumented in order to speed up the flight readiness approval process. Aircraft will be instrumented with over 30 DAUs and 3,000 active measurements which will require an enormous, high-speed PCM format. There are multiple instrumented aircraft at a number of flight test facilities. Traditionally, this would cause a lot of problems due to the database and software residing at only one facility. This problem has been solved with mobile and highly flexible standalone platforms which allow complete system support using a "user friendly" and a "quick to operate" system.

Every member of the F-22 team is able to test and trouble-shoot the CAIS system using easy-to-use tools which allow the system to be tested and trouble-shot without being a CAIS system "expert." This makes the system more serviceable and maintainable while accomplishing this task at a greatly reduced cost to the program.

GSU for the F-22

A GSU configuration was developed to meet the specific needs of the F-22 fighter aircraft. The system was developed using the concepts presented in this paper. A low-cost, ruggedized PC chassis was configured with a combination of commercial data acquisition boards, custom boards for the CAIS requirement, and a combination of commercial and newly developed software. The F-22 GSU block diagram is shown in figure 1 and figure 2.

Computer Platform and Commercial Add-on Boards

The F-22 CAIS GSU is based on the latest Pentium Processor technology and a suite of commercial data acquisition and processing cards. A mobile, rack-mountable chassis contains the processor, keyboard, mouse, Active Matrix Color Display, and internal speaker (for voice playback). Other standard peripheral devices include DRAM memory,

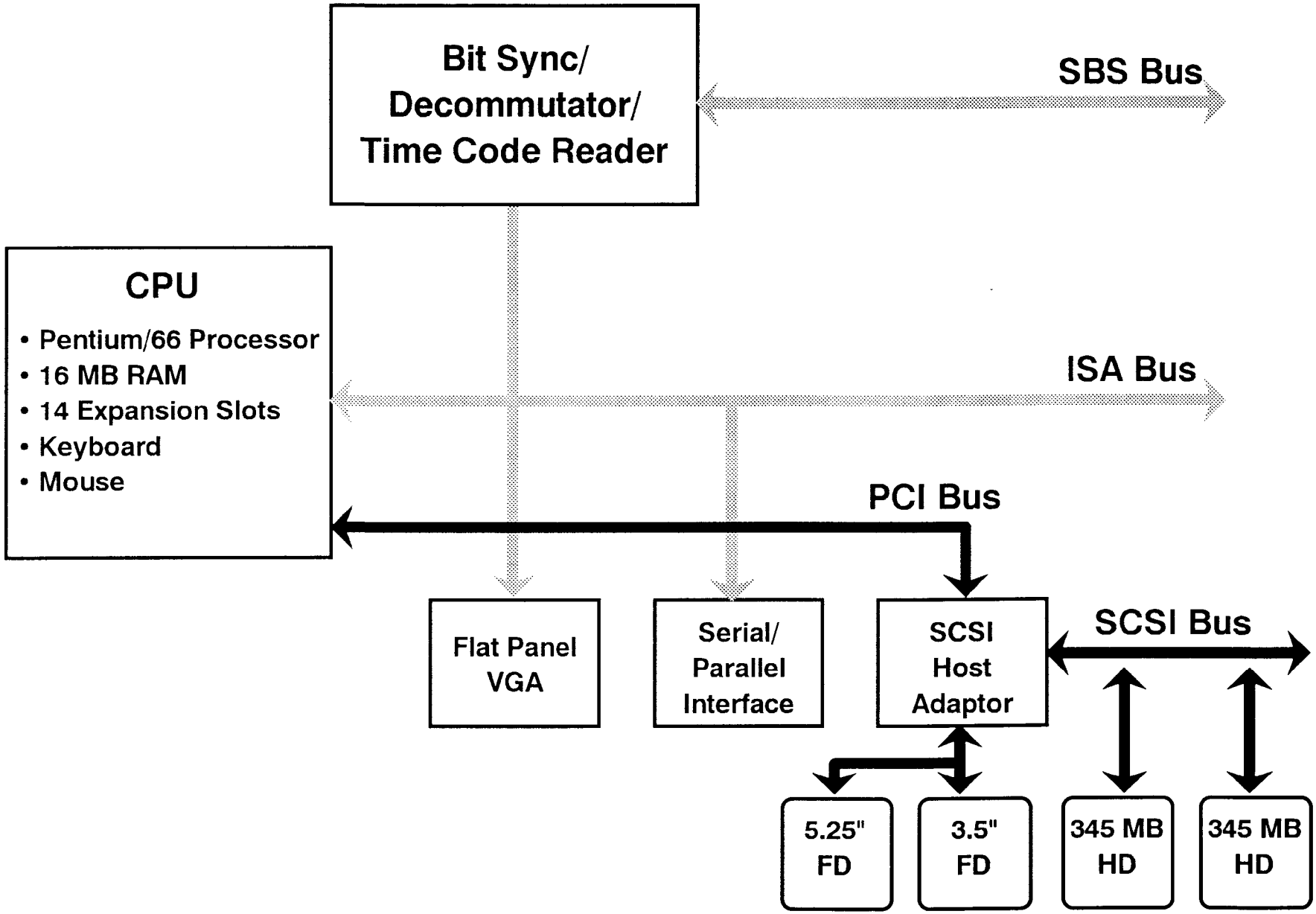

Figure 1. CAIS GSU Block Diagram

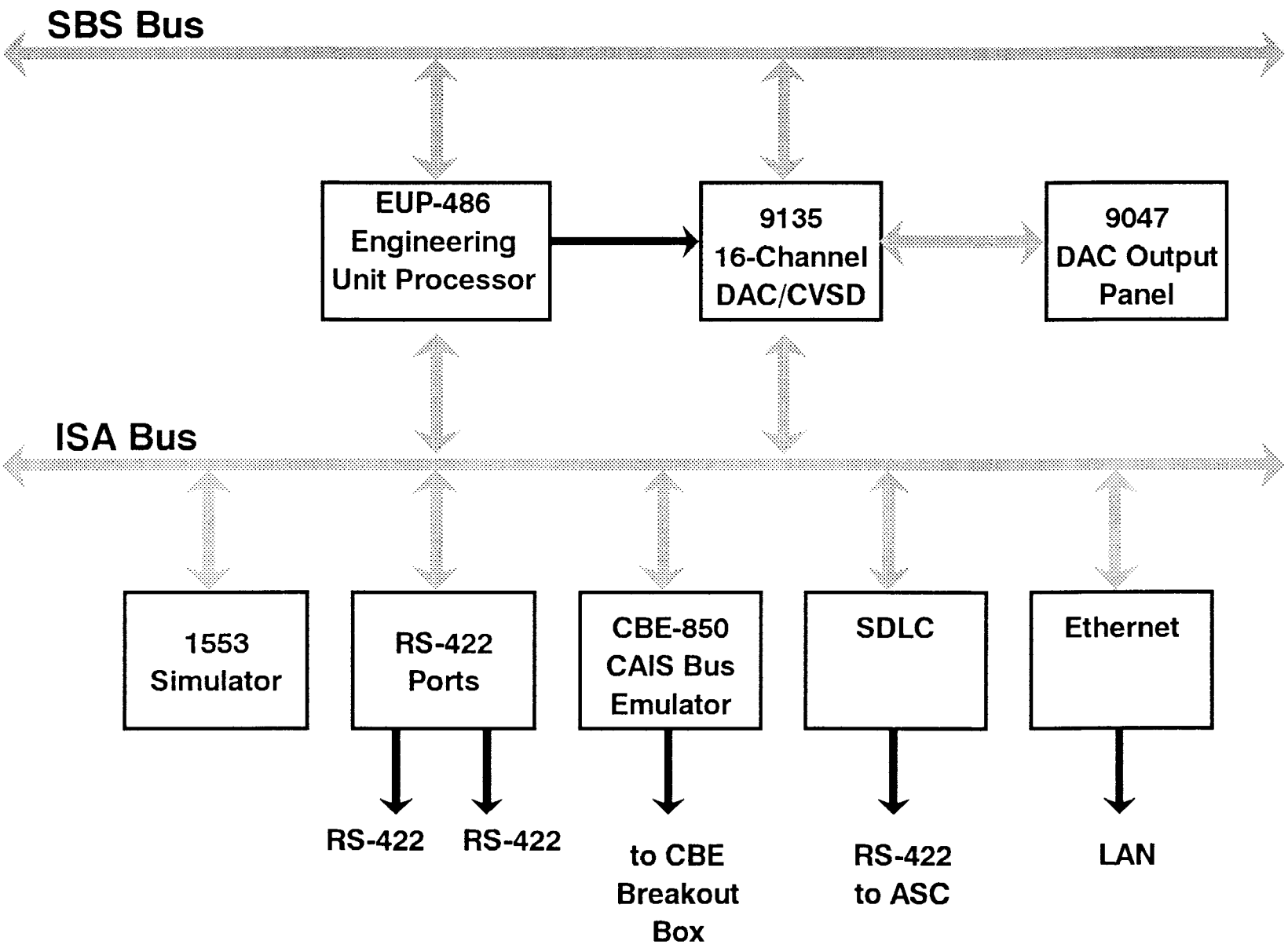

Figure 2. CAIS GSU Block Diagram

hard disk and floppy disk storage, multiple serial/parallel communication ports, and a printing port. The processor itself was sized with 11 spare ISA slots and 3 spare PCI slots to insure future upgradeability.

One of the key add-on cards is the SBS-9100[1] Bit synchronizer, Decommutator, and Time Code Reader. This bit synchronizer handles data rates up to 16 Mbps, differential or single ended inputs, and has a fully programmable front-end which can acquire many types of PCM input coding. The decommutator handles data rates up to 24 Mbps, is compatible with IRIG-106-93 standards, and is fully programmable. The time code reader accepts IRIG A, B, or G, "AC" inputs and is also fully programmable. Another key card is the 9135[2] DAC/CVSD 16-channel card. This card provides CVSD voice reproduction, outputs in either bipolar or unipolar format, multiple output ranges, and is fully programmable. The third key card is the EXC-1553PC/E[3] MIL-STD-1553 Test Simulator. This card provides BC/RT simulation, RT simulation, BC simulation, and remote monitoring capabilities.

Special CAIS Add-on Boards

Two special CAIS cards were added to the F-22 GSU to support direct interface with the CAIS Airborne data acquisition system. The Synchronous Data Link Control (SDLC) card provides the means of communicating with the CAIS Airborne System Controller (ASC). The SDLC port is a differential, 125 kbps half duplex serial interface between the GSU and ASC. This port is used to configure and control all data acquisition aspects of the CAIS System.

The other special card added to the F-22 GSU is the CBE-850, CAIS Bus Emulator card. The card supports four key operational roles for the CAIS airborne data acquisition system:

- Programming of the CAIS remotes
- Emulation of the CAIS Airborne System Controller (ASC)
- Emulation of the CAIS DAU remotes
- Acquisition and filtering of PCM data per IRIG-106, Chapter 8

The card is fully supported with an integrated, Windows-based software program. Each of the four operational roles are now described in detail as they apply to the F-22 application.

CAIS BUS EMULATION

CAIS Master Emulator (CME)

The main purpose of the CME is to emulate the CAIS Airborne System Controller (ASC). The majority of the CAIS components are the Data Acquisition Units (DAU's), which require extensive tests for incoming inspection, lab test and on board aircraft test down to the channel level. The ASC is a very high price item to be used for DAU channel testing. The CME function of the CBE card is a low cost solution to test and verify some of the CAIS components. In addition, the CME emulates the complete format structure of the ASC, down to the OP-CODE of every single instruction. This makes it highly convenient to develop formats for the ASC, and run them using the CME to test/debug the format, without hassle of wiring up an ASC. In other words the CME function turns a PC into a low cost multi-purpose system controller.

The CME supports programmable bit rate to 5 Mbps maximum, selectable bits per word, PCM code, CAIS Bus, Format start address, Simultaneous Sample, and Mode Change bit.

CAIS Bus Emulator (CBE)

Each CAIS Data Acquisition Units (DAU's) contain EEPROM memory which must be loaded for various channel setup and configuration information. The DAU's do not have any industry standard bus (i.e. RS232) for programming their setup. The DAU can be programmed in one of Two ways, through the ASC, or through the CBE function. Programming a DAU through the ASC has several drawback, namely it requires an ASC, and the loading is done through a relatively low speed bus at 125 Kbaud. The CBE allows programming of any DAU directly through the CAIS bus (without an ASC) at programmable rates up to 5 Mbps. The CBE functions use a Dual Port RAM (DPR) directly mapped to the PC memory using the 16 bit bus. The DPR has 1K x 16 for CAIS Command and 1K x 16 for CAIS Reply. An internal 10 millisecond "time out" counter is provided to simplify software when programming EEPROM in the Page Mode. The CBE can also be used to program DAU's through the ASC, at the CAIS bus high rate using the AS's RS-422 repeater port.

The CBE supports programmable bit rate to 5 Mbps maximum, selectable bits per word, Burst/continuous mode, CAIS Bus, start/end address, and Interrupt Enable.

CAIS DAU Simulator (CDS)

During system test if a DAU does not reply to commands received by a system controller, or does not program and verify, the problem can be attributed to the controller, the wiring, or in the selected DAU. The CDS can be used as a tool to allow the user to troubleshoot any DAU in the system by emulating the programming, verification, and proper operation of the DAUs and the ASC in the system. In addition, to verify proper operation of the ASC, one would require to have several DAU's. The CDS eases system problem identification by operating as a general purpose DAU with a programmable DAU address ID. It can be programmed to operate as the only DAU on the CAIS bus, or as one of many DAU's on the bus.

The CDS has several unique feature to allow verification of several modes of operation of the CAIS bus. The CDS includes an EEPROM which can be interrogated by the ASC or a program developer to program and verify a DAU. It includes 2K x 16 Dual Port RAM (DPR), directly mapped to the PC memory bus. Data written by the PC into the DPR is retrievable under format control by the CAIS Controller. The CDS turns the PC into an active DAU on the CAIS bus.

PCM Acquisition

The PCM acquisition function of the CBE card allows the acquisition of an external PCM source, or the local PCM output of the CME function. The PCM function is uniquely tailored to acquire and filter data compatible with IRIG chapter 8. Aydin Vector's ALBUS and the CAIS AVDAU are two known systems that the PCM acquisition can acquire and filter their 1553 data. Most of the data filtering and selection is done on the hardware level. In the case of IRIG chapter 8, one can filter the fill words, and select 1553 data based on its Bus ID. Further filtering is done through software to select down to the 1553 message level and the word level. This function is very useful in testing the AVDAU unit. This quick-look validation of 1553 data eliminates the need to have to make a test tape and have flight test data reduction validate whether the system is operating properly.

Data is selectable from the PCM based on an onboard RAM tag. In addition include a 12 bit DAC output, and a parallel PCM output with tag bits generated by the RAM tag. The PCM requires NRZ-L, Bit Clock, and Frame Clock. It operates up to 16Mbps rate, and has programmable Internal/External data source.

CONCLUSION

All major future U.S. Navy, Airforce and Army test programs will be required to use the CAIS Airborne Data System. To operate, test and maintain this system, unique CAIS specific test equipment is essential to allow efficient use and operation of the system. A PC-based platform utilizing low cost, commercially available equipment makes the ideal platform. Special cards which are unique to the CAIS architecture provide direct access to the inner workings of the CAIS system. An integrated ground support system with multiple, low-cost cards and software provides an extremely powerful method to setup, support, and maintain the CAIS instrumentation system. A lightweight, rack-mounted package allows multiple pieces of support equipment to be integrated into a stand-alone, user-friendly hardware and software package. A Windows-based, multi-tasking software package yields an extremely efficient solution to the challenges faced by today's ground support engineer.

The CAIS GSU combines advanced Commercial Off-The-Shelf (COTS) equipment with specialty CAIS equipment to provide a complete CAIS ground support unit.

1. The SBS-9100 is a product from Terametrix Systems International, Inc., Las Cruces, N.M.

2. The 9135 DAC/CVSD is a product from Terametrix Systems International, Inc., Las Cruces, N.M.

3. The EXC-1553PC/E is a product from Excalibur, Inc., Fresh Meadows, N.Y.