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SITE DATA ACQUISITION SUBSYSTEM (SDAS) MOD 1, INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

Prepared by

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16. ABSTRACT

The Site Data Acquisition Subsystem (SDAS) Mod 1 is designed to collect sensor measurement data from a solar energy demonstration site. This report provides a brief description of the SDAS and defines the installation requirements and procedures, the operations description and the procedures for field maintenance of the subsystem.

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1.0 SCOPE

This document provides a brief description of Mod I SDAS and defines the installation requirements and procedures, the SDAS operations description and the procedures for field maintenance of the SDAS.

2.0 SITE DATA ACQUISITION SUBSYSTEM DESCRIPTION

The Site Data Acquisition Subsystem (SDAS Mod I) is designed to collect sensor measurement data from a solar energy demonstration site. The collected data is stored in the SDAS for subsequent retrieval by the Central Data Processing System (CDPS) which interrogates the SDAS through voice grade telephone lines.

2.1 SYSTEMS OVERVIEW

The solar heating and cooling data collection system consists of the sensors (instrumentation) which monitor the solar system, the SDAS which collects and temporarily stores the collected data, the telephone link which provides the communication link for data retrieval, and the CDPS which gathers, analyzes and processes the data. Figure 2.1-1 gives a pictorial overview of the data collection system.

The site sensors are sampled by the SDAS at either five minute intervals or thirty-two second intervals and averaged every five minutes. The analog signals from the sensors are converted to digital, formatted and stored on a cassette recorder within the SDAS for subsequent retrieval upon command from the CDPS Communication Processor. Each operational site SDAS cassette recorder is polled for data retrieval approximately once every 24 to 72 hours.

Each SDAS is connected to a private phone line communications network. Telephone interfaces include the Bell 202C Data Set (or equivalent) on the CDPS end and 1001F, Series 5 Coupler (or equivalent) on the SDAS end of the lines. The CDPS is programmed to dial each operational site sequentially, at preplanned work-day intervals, until all site data transfers are completed.

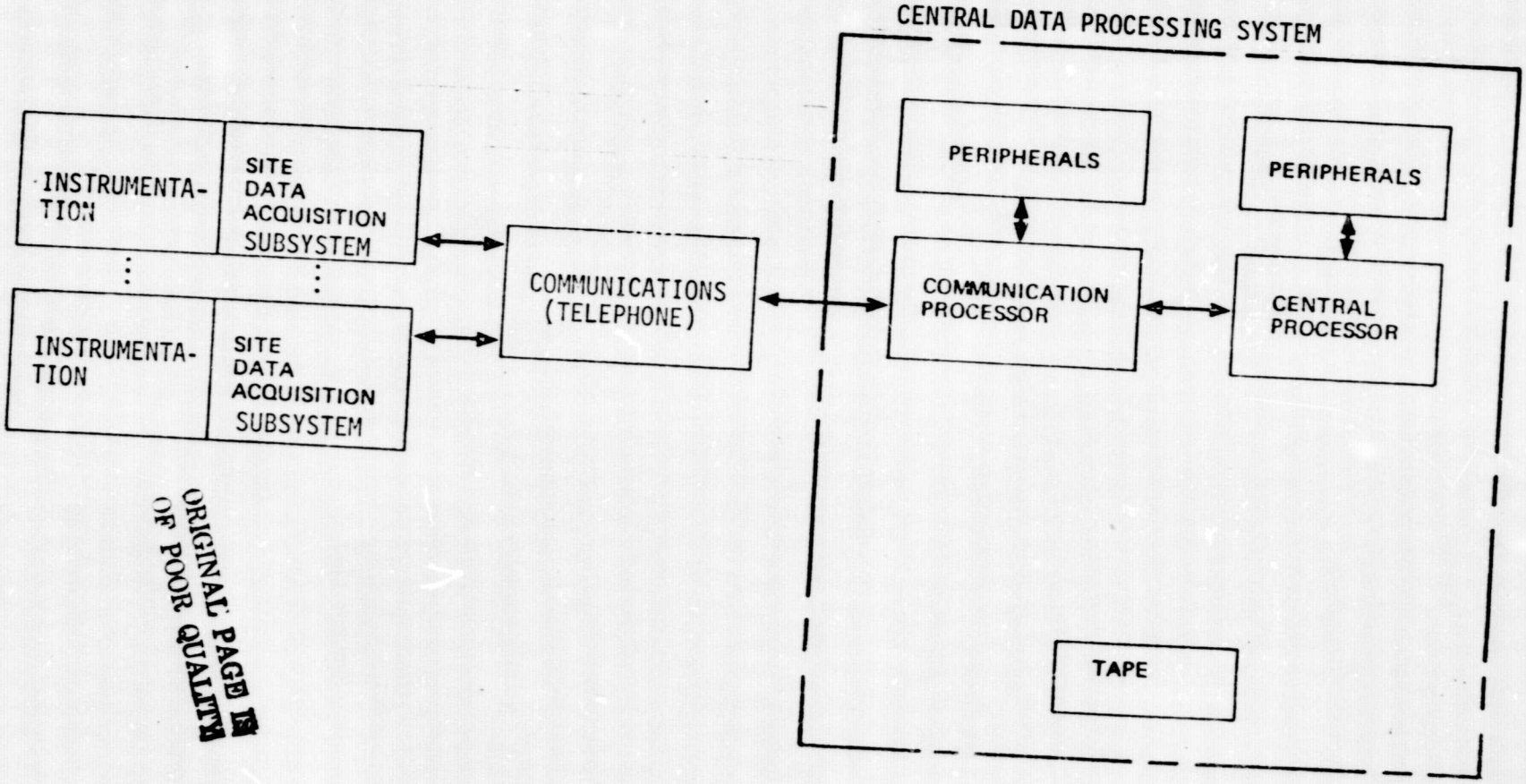

FIGURE 2.1-1 DATA SYSTEM (GENERAL)

2.2 FUNCTIONAL DESCRIPTION

A functional block diagram of the SDAS is shown in Figure 2.2-1. Sensors are installed on the solar energy system in type, quantity, and locations predetermined by analytic requirements. Sensor excitation and output signal interfaces are connected through J-Box terminals to I/O connectors of the SDAS. Under control of the SDAS microprocessor, sensor outputs are sequentially selected through the input channel multiplexer. Input signal conditioning preceeds the multiplexer where required. The multiplexer switched signals are normalized through microprocessor selected gaining amplifiers and digitized by a 10-bit A/D converter.

Multiplexer channel selection, amplifier gains, the tape recorder, communications interface hardware, data flow, and scan buffer storage are all under direct control of the microprocessor. The microprocessor sends and receives data on an 8-bit half-duplex data bus. An interval timer provides for both real-time and control timing for the SDAS. The clock is a crystal regulated timer and sourced from a battery supply to maintain real-time independent of primary AC power. The tape recorder has the capability to read, write, start, stop, rewind and playback. The phone-line coupler interfaces to the SDAS via a modem, configured to operate compatible with the Bell 202C auto call/auto answer service, providing a maximum 1200 BPS data transmission capability over standard voice-grade phone lines.

Expansion of the basic 16 channel capability to accommodate additional sensors is accomplished by the addition of pluggable multiplexer subassemblies. Each added multiplexer provides 16 input channels giving incremental growth capability for handling 32 and 48 analog channels.

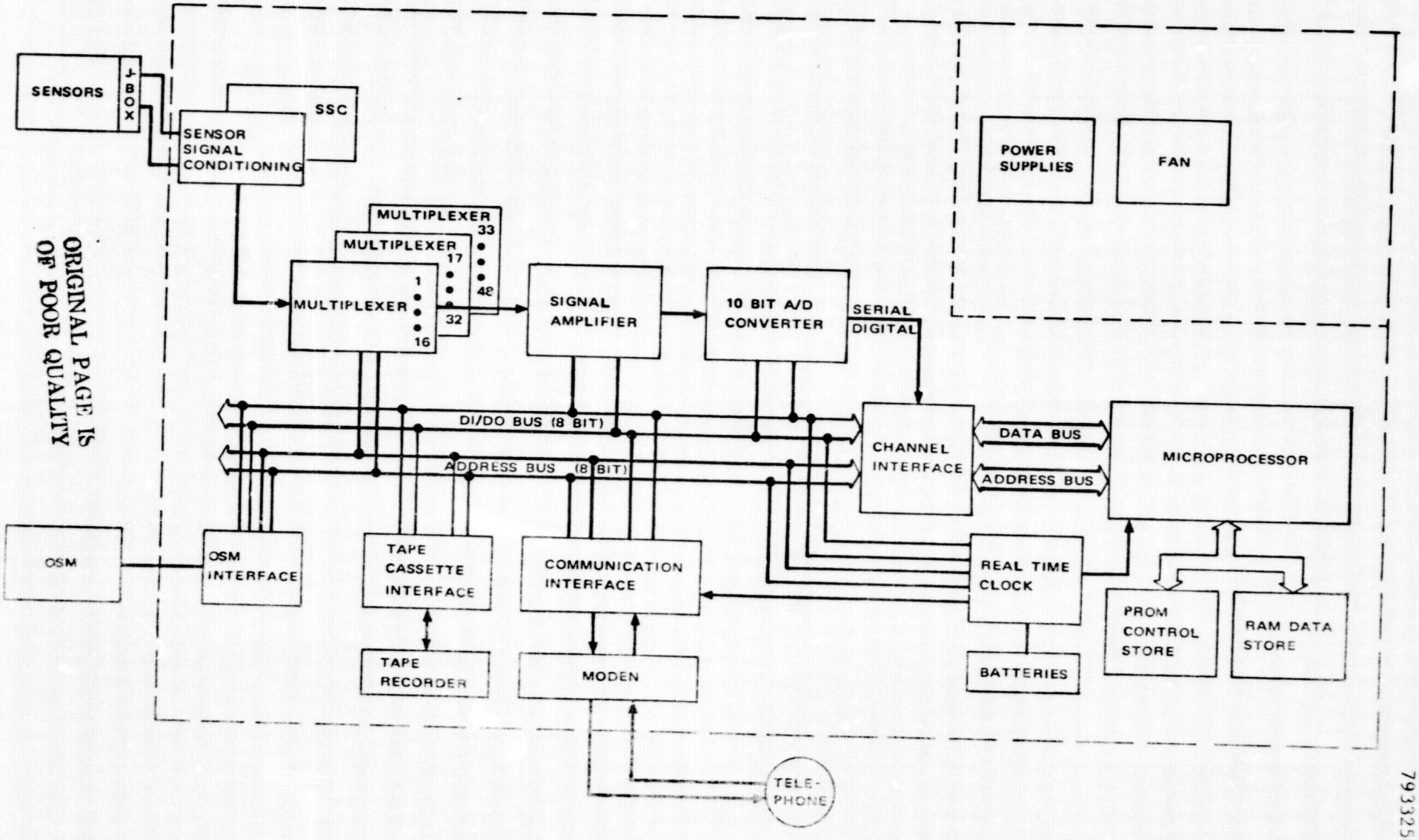

Figure 2.2-1. SDAS Functional Block Diagram

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SDAS Mod I utilizes a modular packaging concept, consisting of pluggable circuit boards and easily removed components to provide ease of maintenance and repair at the site. Depending on the number of analog input channels, there are a maximum of 12 pluggable cards, a fan, a power supply subassembly, a tape recorder subassembly and batteries. The SDAS Primary power, telephone and sensor interfaces are also pluggable so that a failed SDAS can be easily replaced. A tape access lock is provided for security.

2.3 OPERATIONAL DESCRIPTION

The SDAS is designed to operate continuously and unattended. The Baseline Data collection approach is data retrieval, commanded by the CDPS, via voice-grade telephone lines, with manual retrieval of the tape cassette as an option.

For normal operation, the SDAS will collect data from the sensors every five minutes (baseline). The SDAS will provide signal conditioning for selected input channels, will multiplex and amplify the input, if required, and will convert the analog input measurement into a 10-bit digital word. Each parameter will be stored as 1 byte (8 bits) or 2 bytes (10 bits of data in a 16 bit field) depending on the parameter accuracy requirements. Data error checks are added periodically in the data stream. Digitized sensor data is formatted and temporarily stored in an approximately 880 byte data buffer. When the buffer is full, the data is transferred to the tape recorder for longer-term storage.

Approximately once each day, data is retrieved from the SDAS by the CDPS. The CDPS has the capability to issue any of the eight commands given in Table 2.3-1. The SDAS performs the actions and provides the reply information to indicate command implementation as shown in Table 2.3-1. Following is the nominal command sequence and SDAS action for data retrieval:

- CDPS dials and SDAS acknowledges ring with answer tone
- CDPS issues "Read Configuration and End-of-File" command and SDAS writes EOF marker on cassette tape
- CDPS issues "Rewind" command and SDAS rewinds tape cassette
- CDPS issues "Read Tape" command and SDAS transmits data recorded on tape to CDPS
- CDPS checks transmission errors and determines if retransmission of data is necessary
- CDPS issues "Rewind" command and SDAS rewinds the tape to the position for new data recording
- CDPS issues "Disconnect" command and SDAS operations disconnect from the telephone linkup

The SDAS then resumes normal sensor measurement and store operations.

Table 2.3-1 CDPS Command and SDAS Response Summaries

CDPS	SDAS ACTION	SDAS REPLY
Read Configuration and End-of-File	End of file written to tape cassette	Reply message with current Real-Time-Clock reading sent to CDPS
Rewind	Tape cassette is rewound and stops on beginning-of-tape (BOT) marker	Reply message sent to CDPS
Read Tape	Tape cassette is placed in play back mode	Data on cassette sent as reply message
Disconnect	SDAS disconnected from communications	Reply message sent to CDPS
Disconnect and Rewind	SDAS disconnected from communications and tape cassette rewound	Reply message sent to CDPS
Read Configuration*	Information gathered reply message	Reply message sent to CDPS with current SDAS Real-Time-Clock reading
Reinitialize**	A master reset of SDAS hardware and software executed	Reply message sent to CDPS
Wind	Tape cassette is rewound past end-of-tape (EOT) marker and stops	Reply message sent to CDPS

* This command useful for verifying status of SDAS
** Not used during operational data collection.

2.4 PHYSICAL CHARACTERISTICS

SDAS Mod I is housed in a rectangular box approximately 26 inches long by 12 inches high by 12 inches deep. The unit weights approximately 70 pounds. Figure 2.4-1 shows the physical configuration of the SDAS. The unit provides for up to five 37-pin connectors to interface analog inputs and sensor excitation supply to the J-Box and signal interface to the phone-line coupler, and a 3 wire power cord for primary power. A 37 pin connector is included for interface with an On-Site Monitor (OSM). Four 1" X 1" mounting brackets with 1/4" round holes are included 16 inches apart at the top and bottom of the SDAS for mounting. The power supplies are located in an attached, louvered and fan driven cage which provides power supply cooling and is mounted in the right lower portion of the SDAS. The unit has a removable front cover for access to the electronics and a small door on the cover for access to the tape recorder for cassette tape removal without removing the SDAS top cover. The electronics unit is sealed with internal air circulated by a small blower located in the air plenum.

2.5 MAINTENANCE CONCEPT

An SDAS maintenance concept was selected which minimizes training requirements, eliminates requirements for special test equipment at the site, and reduces the number of site visits for problem isolation. Both SDAS components and the packaging design were selected to complement the maintenance concept. A key feature in the maintenance concept is the use of the CDPS to perform an SDAS failure recognition function on parameters returned from the operational sites. In essence the SDAS units will be maintained in the following manner: (1) SDAS failures and some failed SDAS modules are recognized by examining returned data at the central site, and (2) replacement parts are interchangeable and spared at the pluggable assembly level.

No special skills, tools, or test equipment are normally required. Some special test equipment is available for SDAS malfunction analysis, if required. In unique instances, when replacement parts do not correct the problem, a replacement SDAS could be installed. Again, no special equipment or skills are required for this replacement. Scheduled maintenance requirements are shown in Table 2.5-1.

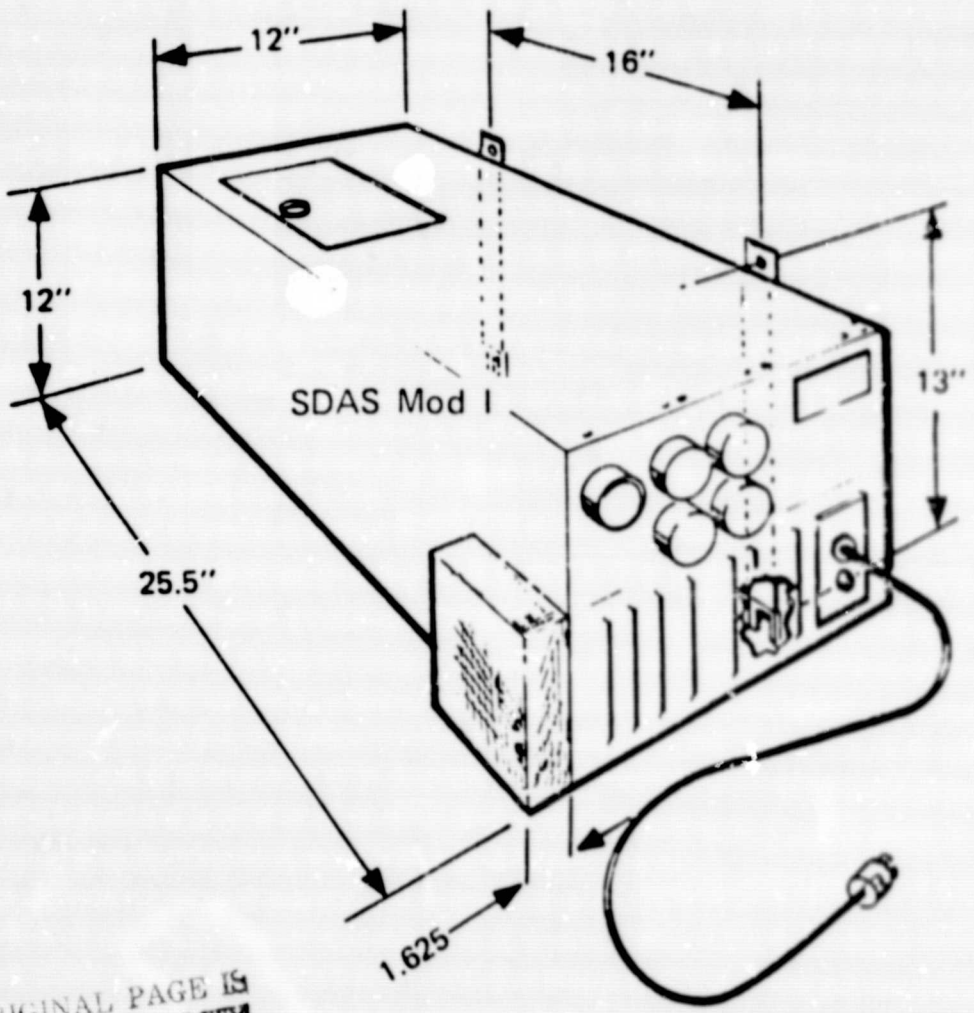


Figure 2.4-1 SDAS Mod I Physical Configuration

Table 2.5-1 SDAS Component Maintenance Requirements

COMPONENT	MAINTENANCE	FREQUENCY
Tape Recorder	Clean Read/Write Heads Replace for Refurbishment	Yearly 2 Years
Tape	Replace when worn	Yearly
Component Failure	Replace failed component	Immediately if critical, during scheduled maintenance if non-critical
Battery (Clock)	Replace periodically	Yearly

3.0 SDAS MOD I SITE INSTALLATION

This Section defines the interface, recommended location and mounting requirements for the SDAS, J-Box, OSM and Telephone Interface (DAA).

3.1 INSTALLATION REQUIREMENTS

The Installation Location selected by the site contractor will meet the location, environment, access and interface requirements as specified in this section and Section 3.2

3.1.1 Location

The relative location of units will be in accordance with IBM Drawing 7932952 and Figure 3.1-1 of this document.

3.1.2 Environment

All units shall be located in an indoor environment having temperature limits of 32°F to 100°F and relative humidity limits of 5% to 80% without condensation. These units shall be located as to minimize contamination by the elements such as dust and other pollutants.

3.1.3 Access

Access to all units shall be in accordance with IBM Drawing 7932952 and Figure 3.1-1 of this document.

3.1.4 Interface

Interface with all units shall be in accordance with IBM Drawing 7932952, Figure 3.1-1 and Section 3.2 of this document.

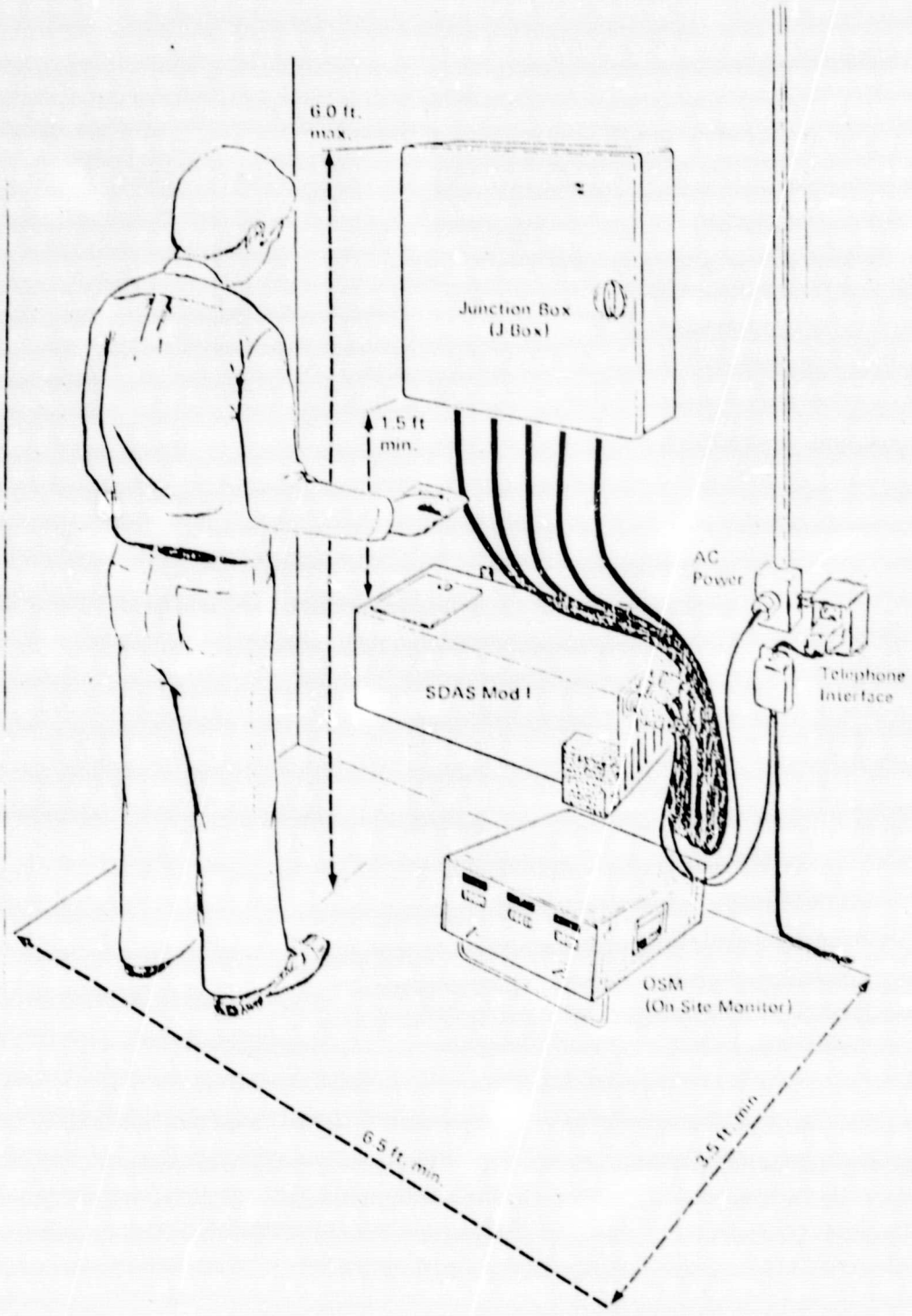


Figure 3.1-1 SDAS Site Installation

3.2 INSTALLATION PROCEDURES

Following are procedures to be followed when installing the SDAS, J-Box, OSM and Telephone Interface (DAA).

3.2.1 SDAS Mounting

The SDAS will be mounted by the Site Contractor using the four (4) mounting bracket holes, two holes at top of unit and two holes at bottom of unit. This unit is to be mounted with either molly bolts, wood screws or a bolt and nut combination. The SDAS must be mounted in a top-up orientation.

3.2.2 J-Box Mounting

The J-Box will be mounted by the Site Contractor using the four (4) mounting holes provided in the J-Box. This unit is to be mounted with either molly bolts, wood screws, or a bolt and nut combination. The Site Contractor will be provided with a wiring list which identifies each sensor and its termination within the J-Box.

3.2.3 Primary Power

Primary Power required for the SDAS will be installed prior to or during SDAS installation by the Site Contractor. The Site Contractor will install a Nema L6-15R (Hubble 4560) receptical located near the SDAS. A six (6) foot cable with a three (3) wire twist lock plug is provided with the SDAS. The Site Contractor will install a standard 3 wire grounding duplex outlet located near the SDAS for OSM and DAA supply. All outlets will be at 110-125V, 60 Hertz, single phase, 15 Amp service.

3.2.4 Telephone Interface

The integration contractor will arrange for proper telephone installation. The SDAS will interface with a Bell System CBS Data Access Arrangement (DAA), 1001F Series 5 type, or equivalent. The SDAS provides a six (6) foot cable with eight (8) termination wires for connection to the DAA. Wires will be connected to the DAA by the integration contractor.

3.2.5 OSM Installation

When an OSM is provided at a site, it will be located so that all switches are accessible and all indicators are readable within a reasonable working area of the SDAS. The OSM includes a 9 ft. signal cable for interfacing to J106 on the SDAS.

3.3 INSTALLATION CHECKLIST

This check list will provide for verification by the Site Contractor and the Integration Contractor that requirements expressed in Section 3 are met.

- J-Box mounted securely at 4 points to the mounting surface
- SDAS mounted in a top-up orientation
- SDAS mounted relative to the J-Box such that 6-foot interface cables will reach
- SDAS mounted securely at 4-points to the mounting surface
- Primary power cord of the SDAS will reach receptacle installed by the site contractor

- SDAS receptacle is twist-lock type with a power source of 110-125V, 60 Hertz, 1 phase, 15 AMP (3 AMP maximum needed by the SDAS)

- The 8 phone-line Coupler wires will reach from SDAS J-105 to DAA and the DAA can be properly accessed.

- J-Box cover can be opened at least 90° without interference

- There are no physical obstructions that would prohibit removal of the SDAS cover.

- No physical damage to installed SDAS and related equipment

- All cabling interfaces securely mated

- All SDAS pluggable assemblies properly installed

- All sensor to J-Box interfaces correctly verified against the J-Box wire lists

- Excitation voltage fuse in the J-Box

- SDAS primary voltage fuse in place and not blown

4.0 SDAS OPERATION

This section describes the normal operation of the SDAS after installation and prior to or after maintenance.

4.1 INITIAL START-UP AND CHECKOUT

After proper installation of the SDAS, the following steps are required to start and initialize the unit:

- Place the primary power (fuse box) circuit breaker in the "ON" position.
- Connect the SDAS primary power cord to the primary power receptacle installed at the site
- Place the SDAS power-on switch to the "ON" position

This action will cause the SDAS microcode to provide an orderly start-up of the SDAS for operation. After start-up, the CDPS interface with the SDAS will be established for initial configuration and checkout. The CDPS can perform the following functions, if required:

- Send the "Reinitialize" command to assure the SDAS is in its proper operational configuration.
- Send the "Rewind" command to assure the tape is in the proper position for data recording.
- Send the "Read Configuration" command to establish the SDAS real-time-clock reading.
- Send the "Disconnect" command to disconnect the SDAS from the CDPS and allow the SDAS to begin data collection.

After the SDAS has taken data for a period long enough to establish its operational characteristics and to store data on tape, the CDPS will re-establish contact with the SDAS and perform the following functions:

- Send the "End-of-File" command to provide an EOF mark on the tape
- Send the "Rewind" and "Read Storage Table" commands to retrieve the data collected by the SDAS.
- Analyze the data retrieved from the SDAS to assure proper operation (CDPS and/or OSM)
- Perform any additional data retrieval or command interface required to evaluate SDAS operation.
- Reconfigure the SDAS for data collection and storage

The CDPS analysis will be coordinated with the SDAS on-site installation personnel to correct any anomalies identified during the CDPS checkout and data analysis.

4.2 NORMAL OPERATION

The SDAS is designed for unattended, continuous operation. Unless maintenance is required, the only operational interface with the SDAS is provided by a telephone interface with the CDPS located at the IBM facility, Huntsville, Alabama. The CDPS provides commands to monitor the status of the SDAS and to retrieve data from the unit. Normal operation will continue until SDAS malfunctions are detected by the CDPS or until SDAS scheduled or unscheduled maintenance is required.

4.3 MANUAL DATA RETRIEVAL

An option exists to manually retrieve cassette tapes from the SDAS. To remove the cassette when the top cover is installed, the tape access door must be unlocked and opened.

The small lever at the bottom right of the cassette holder is pushed to the right to release the cassette and the cassette is removed from the unit. A new cassette, rewound to the beginning of tape, is snapped into the tape recorder and tape access door closed and locked. The SDAS will resume normal operation.

4.4 SDAS RESTART

The SDAS restart sequence is identical to the SDAS start-up sequence except for the case in which unretrieved data is still on the cassette tape. For this case, the data on tape will be retrieved by the CDPS prior to performing the proper commands to assure the SDAS is in its proper operational configuration.

5.0 SDAS FIELD MAINTENANCE

This section describes the procedures for SDAS corrective maintenance. Figure 5.0-1 provides physical and functional reference to the SDAS Mod I field replaceable subassemblies for a fully populated (48 channel) unit.

5.1 MALFUNCTION DETECTION

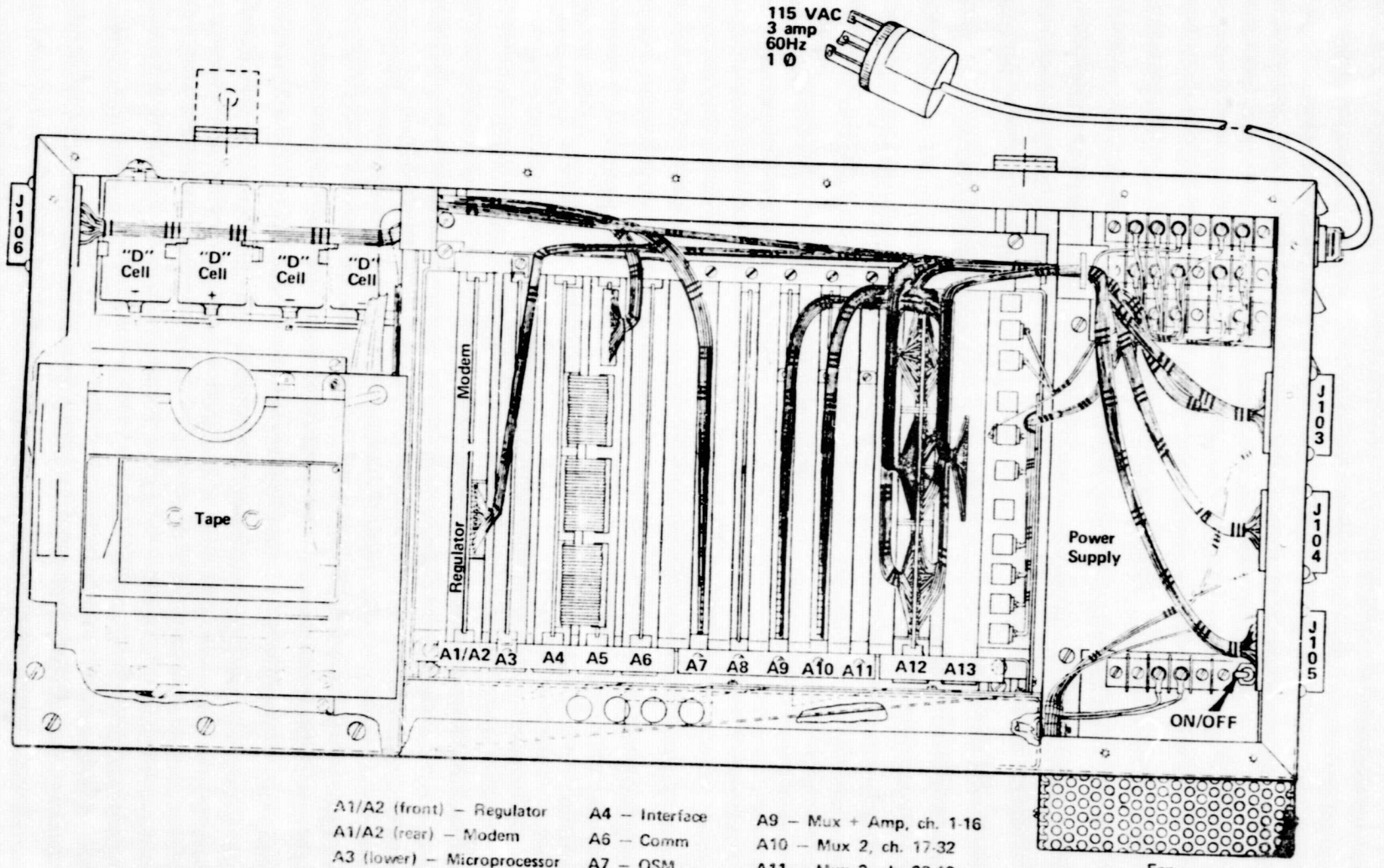
An analysis of data, or lack of data, being received at the CDPS at IBM, Huntsville, Alabama is used to detect, and in most cases, to isolate malfunctions that have occurred in the SDAS. When the malfunction is detected, the data processed by the SDAS will be analyzed to isolate the failure to a replaceable subassembly, if possible. If a replaceable subassembly failure has been detected by the CDPS, a subassembly will be sent to the site for replacement by a trained technician. If the failure cannot be isolated to a replaceable module(s), a SDAS will be shipped to the site to replace the failed unit. Failed items will be returned to the IBM facility for analysis following replacement.

The on-site monitor (OSM) unit, which can be plugged into the SDAS at selected sites, may also be used to aid in the detection and isolation of malfunctions, especially during installation and the initial phases of the program. Detailed utilization of the OSM can be found in IBM document number 7934365, "ON-SITE MONITOR OPERATIONS MANUAL".

5.2 POWER-DOWN SEQUENCE

Prior to performing maintenance on the SDAS, the unit can be powered down by disconnecting the SDAS input power cord, tripping the building circuit breaker, or switching the power on/off switch inside the SDAS unit to the "OFF" position.

The SDAS input power cord should be disconnected prior to opening the SDAS for maintenance. The power cord is disconnected by rotating the power plug counter-clockwise and unplugging from the wall socket.



A1/A2 (front) – Regulator
A1/A2 (rear) – Modem
A3 (lower) – Microprocessor
A3 (upper) – Prom

A4 – Interface
A6 – Comm
A7 – OSM
A8 – AI Basic

A9 – Mux + Amp, ch. 1-16
A10 – Mux 2, ch. 17-32
A11 – Mux 3, ch. 33-46
A12 – SC1, ch. 1-32
A13 – SC2, ch. 33-48

Figure 5.0-1 SDAS Mod I Subassembly Reference

The SDAS top cover is removed by extracting the screws from along all four edges of the top panel. The internal on/off switch is located in the front, right hand corner of the mounted SDAS. Assure that this switch is in the "OFF" position before extracting or installing any subaasemblies.

5.3 SUBASSEMBLY REPLACEMENT

The following sections describe the procedure for replacing subassemblies in the SDAS. The replaceable subassemblies include up to twelve pluggable cards, the tape recorder, the power supplies, batteries, and fan.

5.3.1 Pluggable Printed Circuit Board Subassemblies

The pluggable printed circuit boards, located in the center of the SDAS, may be removed by unplugging the wiring connectors at the top of the board to be replaced and pulling the board up the guides and out the top of the SDAS. Some of the cards use holddowns to retain the card in the holder. These must be loosened prior to board removal. The replacement board is plugged in with care to assure proper location, orientation and seating. All cards are mounted with the component side facing toward the power supply end of the SDAS. See Figure 5.0-1 for reference to card-type location assignment.

Verification of proper card seating should be done visually with reference to the backpanel connector base. It may be necessary to remove more than the single replacement card and than sequence card insertion so as to achieve visual inspection of each inserted card connector base reference. Always achieve a good connector and guide-rail alignment before applying heavy pressure to the top of the card. Attempts to insert a card type in other than its assigned location must be avoided.

5.3.2 Tape Recorder Subassembly

After power is disconnected and the SDAS cover is removed, the tape recorder subassembly may be removed. First remove the four screws at the corners of the recorder mounting base. Lift the recorder to the top edge of the SDAS housing and unplug electrical connectors from the recorder. Installing the recorder subassembly is an abvious procedure after executing the removal steps. Mount the recorder subassembly with the record head disengaged and to the front.

The procedure for tape cassette replacement is described in Section 4.3.

5.3.3 Power Supply Subassembly

When working on this area of the installed system, take special precautions to assure that primary power is not inadvertently applied until work is completed. Unplug the SDAS primary power from the wall socket prior to any work on the SDAS power supply.

The power supply subassembly can be removed from the SDAS while the SDAS remains mounted, given that site installation requirements expressed herein are met. After removing the top cover of the SDAS, place the SDAS power on/off switch to the "OFF" position. Remove wiring from TB-1 thru TB-4 by extracting terminal screws from the ring tonque terminals. Assure that each wire properly identifies its termination point to facilitate rewiring to the new supply.

Support the power supply subassembly to prevent it from falling free while removing the power supply mounting screws. After assuring adequate support, remove the twelve mounting screws that adjoin the SDAS chassis to the top of the power supply subassembly.

Install the new supply by supporting it in place while installing the 12 mounting screws. Reinstall wiring to TB-1 thru TB-4, assuring that each wire is returned to its proper termination. Plug the new supply's primary power cord into the appropriate wall socket and place the SDAS on/off switch to the "ON" position. The SDAS restart procedure is then used to restart subsystem operation.

5.3.4 Fan Subassembly

Before replacing the fan, unplug the SDAS primary power cord from the wall socket. Remove two upper and two lower screws from the fan cage and remove cage. Unplug the fan power connector from the fan subassembly. Extract the screws from the four corners of the fan while preventing it from falling free to the floor. New fan installation is an obvious procedure.

The blower in the plenum is not a field replaceable subassembly.

5.3.5 Battery Replacement

The four alkaline D cells which power the real-time-clock are located in the upper left portion of the SDAS. Discharged batteries are removed by first extracting hold-downs from across the top of each cell. The cells can then be extracted from the holder. After cleaning holder, apply a thin coating of No. 4 Dow Corning compound on the battery side of holder contacts. Insert fresh cells with careful attention to the required polarity.

5.3.6 Fuse Replacement

The primary power fuse, 3AG 3 amp slow-blow, is replaced by extracting the blown fuse from the panel mounted fuse holder and inserting a new one. The fuse holder, adjacent to the primary power cord, is accessible without removing the SDAS cover.

5.4 SDAS REPLACEMENT

To replace the entire SDAS unit, the SDAS primary power cord is disconnected from the wall socket.

The sensor, telephone, OSM and I/O cables are removed from the SDAS by unplugging connectors J101 through J106.

The SDAS may then be removed from its mounted position by removing the four mounting bolts (2 at the top and 2 at the bottom mounting flanges). The replacement unit is installed using the same mounting points and hardware.

The following procedures should be implemented to reconnect the SDAS and restore operation:

- Connect sensor, telephone, OSM and I/O cables J101 through J106
- Connect SDAS primary power cord
- Connect OSM primary power cord
- Switch the OSM "ON-OFF" switch to the "ON" position
- Verify proper SDAS operation via OSM and/or CDFS telephone link-up