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A TECHNICAL DESCRIPTION OF THE AUTOMATED TECHNICAL CONTROL (ATE--ETC(U)

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In-house Report
February 1977

A TECHNICAL DESCRIPTION OF THE AUTOMATED TECHNICAL CONTROL (ATEC) SYSTEM AN/GYM-12(V)

Senatro J. Iuorno

Approved for public release; distribution unlimited.

ROME AIR DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
GRIFFISS AIR FORCE BASE, NEW YORK 13441

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This report contains technical descriptions of the Automated Technical Control (ATEC) equipments which comprise the Communications Performance Monitoring-Assessment System AN/GYM-12(V). The AN/GYM-12(V) and its major subsystems provide automated performance monitoring and assessment of communications circuits and equipments in Technical Control Facilities (TCFs) of the Defense Communications System. (Cont'd)

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The heart of the AN/GYM-12(V) is the Nucleus Subsystem (NSS), which provides centralized control for automated performance assessment of communications monitored by a TCF. Located within the geographic control area served by the NSS are the following ATEC Terminal Elements (ATEs), the subsystems which perform the actual monitoring and interactive tests with the communications systems.

Programmable ATEC Terminal Element (PATE)

Baseband Signal Analyzer (BBSA)

Alarm Reporting Subsystem (ARS)

Measurement Acquisition Unit (MAU) and MAU Options

The ATEs permit the AN/GYM-12(V) to monitor at any point within the communications network, from a single digital or voice frequency (VF) circuit to a broadband radio link containing many circuits. The PATE is used for monitoring VF, digital data, and frequency shift keyed (FSK) communications circuits. The BBSA permits wideband measurements to be made at the group, supergroup and master group level and translates selected channels from the baseband to the VF band for sepaiate analysis. The ARS is used to continuously monitor the status of various communications equipment internal alarms. The MAU is used to monitor VF signal levels and dc voltages. Various equipment options allow the MAU to accomplish additional monitor/test functions.

The material in this report proceeds from a system level description of the AN/GYM-12(V) and its major subsystems; to a block level discussion of the NSS with detailed descriptions of the NSS prime and peripheral equipment; to detailed descriptions of the PATE, BBSA, ARS, MAU, and MAU Options. The performance capabilities and design characteristics of the individual AN/GYM-12(V) equipments are presented in tabular form. Equipment block diagrams and photographs are provided. Applicable ATEC specifications, manuals, reports and other documents are listed.

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SECTION 1

INTRODUCTION

1.1 PURPOSE

The purpose of this report is to provide technical descriptions of the Automated Technical Control (ATEC) equipments which comprise the Communications Performance Monitoring-Assessment System AN/GYM-12(V). The CPMAS and its major subsystems provide automated performance monitoring and assessment of communications in Technical Control Facilities (TCFs) of the Defense Communications System (DCS). The equipment descriptions contained in this report are based on the ATEC development and initial production programs conducted by the Air Force under Contracts F30602-72-C-0088 and F30602-75-C-0225, respectively. It is intended that this report will provide the reader with a comprehensive reference of capabilities and leading particulars of the AN/GYM-12(V).

1.2 TECHNICAL CONTROL FACILITIES

Generically, technical control is the continuing supervision of the operating condition and employment of those facilities and associated equipment that comprise a telecommunication system to insure that operational requirements are being satisfied. In the strategic military communications environment, technical control can be operationally defined as the configuration management, quality control, and status reporting of the communication circuits and equipments in the worldwide Defense Communications System (DCS).

A Technical Control Facility (TCF) provides the interface between the users of a communications system and the transmission facilities. TCFs are located at various points throughout the DCS so that efficient system operation can be maintained. TCFs of the DCS vary widely in the number of circuits and the size of the area under their jurisdiction.

A TCF may interface landlines, submarine cables, microwave links, troposcatter links, high frequency (hf) radio stations or satellite terminals. The TCF usually is located in a separate building or room within a communications site. It consists of the equipment required for patching, coordination, testing, monitoring and reporting, interfacing circuits, and conditioning circuits. Skilled technical control operators utilize this equipment to evaluate communication circuits and system performance and implement rerouting and circuit restoral procedures in case of degradation or outages.

1.3 ATEC OBJECTIVES

The objective of ATEC is to provide TCFs with the means for rapid, accurate communications system performance assessment, fault determination and isolation, and communications restoral. ATEC is not intended to replace presently installed manual equipments, but to supplement them with economical and efficient computer controlled devices to perform repetitive tasks, automatic measurements, and simplify analyses. Thus, ATEC greatly alleviates the manual time-consuming tasks previously required of the technical controller and allows him to take on greater decision making functions.

1.4 BACKGROUND

1.4.1 Prototype DCS Stations.

The Defense Communications Agency (DCA), early in 1962, contracted for three prototypes of a DCS Station Control Subsystem designed for semi-automated preparation of station logs, generation of trouble work sheets, and display of both traffic backlog and station status. A small, general purpose, stored program computer, special displays, and a teletype readout were used in the station control subsystem. Test and evaluation in 1963 showed that the control subsystem concept was of assistance to technical controllers in preparing reports, logging events, and displaying results. Studies on the application of automated sensing devices in the DCS continued and resulted in the Source Data Automation Study in 1963. This study reviewed sensors, suggested a configuration, and concluded that application of sensors in the Defense Communications System (DCS) would be fruitful. At this time, the Army requested that the study be redirected to examine technical control problems in a significant portion of the DCS known as the European Tropo-Army (ETA).

1.4.2 ETA Study.

The ETA study resulted in a comprehensive plan to automate operations at Technical Control Facilities (TCFs). The study report, entitled Automated Facilities Report (1965), discussed orderwire requirements and considered interface problems. The report suggested several levels of automation that could be progressively implemented in a logical fashion. It concluded that automation was feasible using existing technology and that it would result in major benefits. The report recommended that automation be implemented as soon as possible.

1.4.3 Automated Quality Monitor Reporting Subsystem.

In 1966 the Army awarded a contract to Stelma, Incorporated, based upon the Automated Facilities Report, for an Automated Quality Monitor Reporting Subsystem (AQMRS) that was installed at the DCS station in Coltano, Italy in 1968. The AQMRS scans and monitors broadband transmission groups to determine the quality of voice circuits, and generates formatted reports and a station log. In 1967, the Army contracted for a more advanced system. This system, called the Automated Technical Control System (ATC)-(SEMI), was installed in the DCS station at Ft. Detrick, Maryland, in 1970. Evaluations of ATC-(Semi) concluded that computer assistance reduced outage time, resulted in early identification of transmission system deficiencies, produced a more stabilized station workload, and contributed significantly to the identification of circuit deficiencies (and hence more efficient correction).

1.4.4 Feik Report.

In 1967, the Air Force also prepared a concept paper that reviewed technical control problems and made recommendations that included automated assistance to the technical controller for certain functions. This paper, entitled "Concept for Semi-Automated Technical Control (SATEC) for Communications Facilities" (Feik Report), listed nine problem areas and recommended six areas where automation would provide significant improvement. The recommendations included means for implementing failure prediction, providing continuous proof of performance and for increasing standardization and modularity.

1.4.5 RADC Development/Initial Production/Installation.

As a result of the efforts mentioned above, the concepts for applying automation to assist technical controllers was well established. In 1969, the Air Force through RADC, awarded separate program definition study contracts to both Honeywell, Incorporated (F30602-69-C-0115), and Philco-Ford Corporation (F30602-69-C-0116).

In early 1970, the technical reports prepared by the two contractors were submitted to RADC and an evaluation team was assembled from the three services and DCA to review them. The review and evaluation was completed in February 1970. The Tri-Service and DCA evaluation team report recommended the Honeywell approach to technical control automation. The program was then titled Automated Technical Control (ATEC).

1.4.5.1 Development. A Statement of Work prepared by RADC based upon the Honeywell Technical Report, earlier efforts, and with Tri-Service and DCA review and coordination was submitted to Honeywell. As a result, Contract F30602-72-C-0088 was awarded to Honeywell in December 1971, to design, build and field test the ATEC Stand Alone Elements (SAEs). In addition, the system level equipments were to be designed, built, and tested in-plant. An effort to accomplish a full Tri-Service ATEC System test overseas is currently ongoing and represents the last stage of the full-scale development phase of the ATEC Program. The system level testing is a Director Telecommunications and Command Control Systems (DTACCS) requirement specified in two memos, dated 27 July 1973 and 17 June 1974. The objective of the system level study, test and evaluation directed in these memos was to identify and provide additional operational data upon which to evaluate equipment performance and to establish new and/or revised standards and procedures. Further, the testing is to resolve the questions as to the operational and cost benefits to be derived from the ATEC Nucleus Subsystem.

1.4.5.2 Initial Production. In June 1975, RADC awarded an initial production contract (F30602-75-C-0225) to Honeywell for the fabrication of a small number of additional models of the developed equipment for use at Army and Navy sites. With the exception of the equipment to be installed at the Naval Communication Station, Norfolk, Virginia, these equipments will be used for the Joint Initial Operational Test and Evaluation (JIOT&E) scheduled for 1976-1977. This fixed price type contract covered the fabrication and in-plant test of the equipment, spare parts, and refinement and upgrading of specifications; also included were contract options covering engineering documentation for reprocurement and complete logistics support data.

1.4.5.3 Installation/Operation & Maintenance (O&M). In August 1976 RADC awarded a separate support contract (F30602-76-C-0420) to Honeywell to provide for field installation of equipment produced under the initial production contract for the CONUS site and European sites. This contract will also provide for contractor maintenance and engineering support of the installed equipment through the end of the JIOT&E period.

1.4.6 AFCS System Engineering Technical Assistance.

In an effort to improve the operational effectiveness of the RADC/Honeywell developed ATEC System, the Air Force Communications Service (AFCS) added tasks in 1975 and 1976 to their System Engineering Technical Assistance (SETA) contract with Computer Sciences Corporation (CSC) to develop operational algorithms. This effort includes hardware (an HP 21MX computer) and software that will be integrated with the RADC/Honeywell ATEC assets in the field to augment the planned JIOT&E test activity. Successfully demonstrated capabilities will be considered in planning the Final ATEC Production Procurement.

1.4.7 ATEC Program Redirection.

As a result of a revised ATEC Concept of Operation published on 10 June 1976, HQ USAF requested that the basic approach to a Final ATEC Production Contract be changed from the utilization of design specifications based on the Honeywell production equipment to the utilization of performance specifications. The Air Force expanded their initial request and developed an overall approach to the utilization of performance specifications from both the management and technical aspects. This approach, referred to as the "ATEC System Acquisition Strategy", was presented to the Director, DCA and the Technical Control Improvement Program (TCIP) Phasing Group on 10-11 March 1976. The acquisition strategy for the Final ATEC Production Procurement includes the following overall objectives:

a. Reduce Manpower/O&M Costs

b. Improve DCS Performance

c. Increase Equipment Modularity/Flexibility

d. Incorporate Existing Technology

e. Reduce Procurement Costs

f. Consolidate Data Base Maintenance

g. Optimize Man/Machine Interface.

1.4.8 RADC Digital ATEC Efforts.

a. ATEC Digital Adaptation Study. In June 1975, RADC awarded Contract F30602-75-C-0282 to Honeywell, Incorporated, to analyze and demonstrate the adaptability of existing RADC/Honeywell developed CPMAS equipment to provide automated monitoring of the initial digital portion of the European DCS. The results of this effort will serve as inputs to the Final ATEC Production Procurement.

b. ATEC Techniques For PCM/TDM. In order to provide a complete digital CPMAS capability, RADC, in October 1976, awarded Contract F30602-76-C-0433 to GTE Sylvania to develop techniques for automated monitoring of Pulse Code Modulation (PCM) and Time Division Multiplex (TDM) microwave upgrades to the DCS.

SECTION 2

AN/GYM-12(V) SYSTEM DESCRIPTION

2.1 GENERAL

The Communications Performance Monitoring Assessment System (CPMAS) AN/GYM-12(V) provides an assortment of automated technical control capabilities to provide a complete performance monitoring capability which may be tailored to specific site needs. The CPMAS equipment can be operated independently or used under control of a centralized facility called the Nucleus Subsystem (NSS). The NSS, as the name implies, is located at a central facility and provides a hub for all CPMAS activity. One CPMAS may cover a large geographical area that includes a number of Technical Control Facilities (TCFs). Normally, the TCF within the area that is either the busiest or most central node will be the location for the NSS. Elsewhere within the geographical area assigned to the CPMAS, are other individual monitoring subsystems which perform a remote measuring function for the NSS. These ancillary subsystems are called ATEC Terminal Elements (ATEs). Although the ATEs are integral parts of the total CPMAS, they can also operate as individual test systems, independent of the NSS, for special applications or for when the NSS is inoperative. When one of the measurement subsystems (ATEs) is deployed to be used independent of the NSS, it is considered as a Stand-Alone Element (SAE). The designators ATE and SAE are sometimes used interchangeably, since they may refer to the same equipment.

2.2 SYSTEM FUNCTIONS

The primary function of the CPMAS is to provide the means to assure communication system quality and integrity within acceptable levels. The CPMAS hardware uses computers to control the monitoring functions, allowing the equipment functions to be easily extended beyond that of simply a measuring device. The CPMAS, in its various configurations, makes maximum use of this automatic capability to perform the overall system functions discussed in the following subparagraphs. The various functions performed by the individual CPMAS equipments are listed in Table 2-1.

2.2.1 Performance Assessment.

Performance assessment is much more than simply monitoring and testing. CPMAS performance assessment consists of providing the operator with the information required to determine past and present performances and to predict the expected future quality of a communications system's performance. The system makes repetitive measurements of critical communications system parameters and continually compares them to the expected performance limits that are stored in the system's data base.

TABLE 2-1. CPMAS EQUIPMENT FUNCTIONS

FUNCTION	SYSTEM EQUIPMENT
Information Retrieval, Analysis Control and Reporting	Nucleus Subsystem A. Central Processor Set B. Data Concentrator Set C. Technical Control Console D. Teletypewriters
Voice Frequency Circuit and Channel Assessment	1. Programmable ATEC Terminal Element (PATE) 2. Measurement Acquisition Unit (MAU)
VFCT FSK Subchannels	Programmable ATEC Terminal Element (PATE)
Digital Circuit Assessment	Programmable ATEC Terminal Element (PATE)
Teletype Circuit Assessment	Programmable ATEC Terminal Element (PATE)
Wideband System Assessment	1. Baseband Signal Analyzer (BBSA) 2. Measurement Acquisition Unit & Options
Equipment Alarm Monitoring	Alarm Reporting Subsystem (ARS)

As long as the measured values lie between the upper and lower acceptable limits, the system identifies the parameters as "green" to the operator. When the "green" boundary is crossed, the system identifies the parameter as "amber" as long as a second set of critical upper and lower limits is not exceeded. When the operator is alerted to an "amber" condition, he may begin problem isolation to locate the source of the degradation before an actual communications failure occurs. The fault determination and isolation procedures are assisted by automated features within the CPMAS. If the measured parameter value crosses the second set of critical boundary limits, the parameter is considered "red" and a communications system failure has probably occurred. To minimize the occurrence of "red" conditions, the CPMAS performs a function called trend sensing. Trend sensing, or trending is an analytical process where a data sample is compared with previous data samples and the direction that the data is taking is determined. Trending can be used to provide the operator with information that a given parameter is degrading and should be investigated.

The CPMAS hardware, with its associated software, can monitor at any point within the communications network, from a single DC (Digital Communications) or VF (Voice Frequency) circuit to a broadband radio link containing many circuits. When the CPMAS is employed in monitoring circuits, the system configuration is identified as a Circuit Performance Assessment Subsystem (CPAS) and uses the particular ATEC elements designed for this level of measurement. When monitoring microwave links, the functional hardware is identified as the Transmission Performance Assessment Subsystem (TPAS). The TPAS system allows conprehensive wideband measurements to be made at the Group, Supergroup, and Master Group level, and permits selected channels to be translated from the baseband to the VF band for separate analysis. To supplement the circuit and link performance monitoring capability, Alarm Reporting Subsystems (ARSs) are used as ancillary equipment to enable the CPMAS to continuously monitor the status of the various communications equipment internal alarms.

2.2.2 Fault Determination and Location.

When the operator is alerted of a fault, or potential fault, he must exercise certain decisions to verify the location and nature of the problem. When using manual technical control fault isolation, the operator was required to verbally track (by use of orderwire facilities) the problem through the communications network until the problem source was isolated. Before the trouble was isolated, this time-consuming coordination often included tests at many TCFs, performed by many operators. Using CPMAS, an operator at a central location, the NSS, has the capability of performing many tests automatically through the communications network under his control. The results of the tests performed at several associated TCF's allow the central operator to verify the fault and locate the source of the trouble.

2.2.3 Reroute Assistance.

After a fault has been located, the technical control operator must identify alternate paths that can be utilized to reroute the traffic around a defective equipment or communications segment. With CPMAS, this task is simplified since the communications system data base at the NSS can contain performance information that would assist the operator in choosing appropriate alternate routes.

2.2.4 Report Formatting Assistance.

To obtain maximum use of the system and provide inputs for off-line analysis of both the communications system as well as the system monitoring the performance (CPMAS), various systematized reports are required. CPMAS simplifies this task and eliminates the major source of errors by providing automated reporting assistance to the operator. CPMAS keeps track of the time required for reporting, when outages have been experienced, and provides the necessary historical data and the required report format.

2.2.5 Station Log Keeping.

CPMAS minimizes the time-consuming manual task of keeping a historical record of the station activities. Automatic entries are provided as activities are executed, or the operator can annotate the log with separate entries. All entries are stored in the system memory for later recall or printout upon demand.

2.3 SYSTEM EQUIPMENT

Table 2-2 lists all of the equipments used in the CPMAS along with their assigned military nomenclature.

A simplified block diagram of the CPMAS is shown in Figure 2-1. A brief description of the major elements of the CPMAS is contained in the following subparagraphs. More complete descriptions of these elements are presented in Section 3 (NSS Description) and Section 4 (ATE Descriptions) of this report.

2.3.1 Nucleus Subsystem (NSS).

The Nucleus Subsystem (bounded by the dashed line area shown in Figure 2-1) is the operational center of the CPMAS. The NSS consists of a Central Processor Set (CPS) with extensive input/output capability (memory disks, magnetic tape, card reader, and paper tape reader); a Data Concentrator Set (DCS); one (or more) associated Technical Control Console(s) (equipped with visual and audible indicators, alphanumeric keyboard, a multifunction keyset, and a cathode-ray tube to display alphanumeric information); and teletypewriters.

TABLE 2-2. CPMAS EQUIPMENTS

COMMON NAME	NOMENCLATURE
Nucleus Subsystem (NSS)	Data Analysis Central AN/GYK-28(V)
Central Processor Set (CPS)	Data Analysis Control Group OL-143(V)/G
Technical Control Console (TCC)	Console, Control-Indicator OJ-341/G
Data Concentrator Set (DCS)	Computer Group, Digital OL-144/G
Programmable ATEC Terminal Element (PATE)	Test Set, Electronics System AN/GYM-13(V)
Baseband Signal Analyzer (BBSA)	Translator Group, Signal Data OM-50/G
Alarm Reporting Subsystem (ARS)	Alarm Monitor Group, OD-123(V)/G
Measurement Acquisition Unit (MAU)	Test Set Group, Communications Circuits OQ-224(V)
ATEC VF/DC Scanners	OK-329(V)1/G Scanner A; OK-329(V)2/G Scanner AC
Test Signal Source (TSS)	Generator, Signal SG-1101/G
Pilot Monitor (PM)	Multiplexer-Power Supply Group OB-81(V)
Baseband Monitor (BM)	Converter-Monitor Group, Baseband OU-116(V)
Reflected Power Sensor (RPS)	Generator Group, Direct Current OV-67/G
Switching Loopback Group (SLG)	Switching Group, Radio Frequency OK-304(V)/G
Noise Loading Group (NLG)	Generator Group, Signal OV-66(V)/G
Idle Line Seizure Controller (ILSC)	Detector, Idle Circuit DT-576/G
Voice/Data Combiner (V/DC)	Not Required
Noise Stop Filter (NSF)	Filter Assembly, Electrical F-1419(V)/G

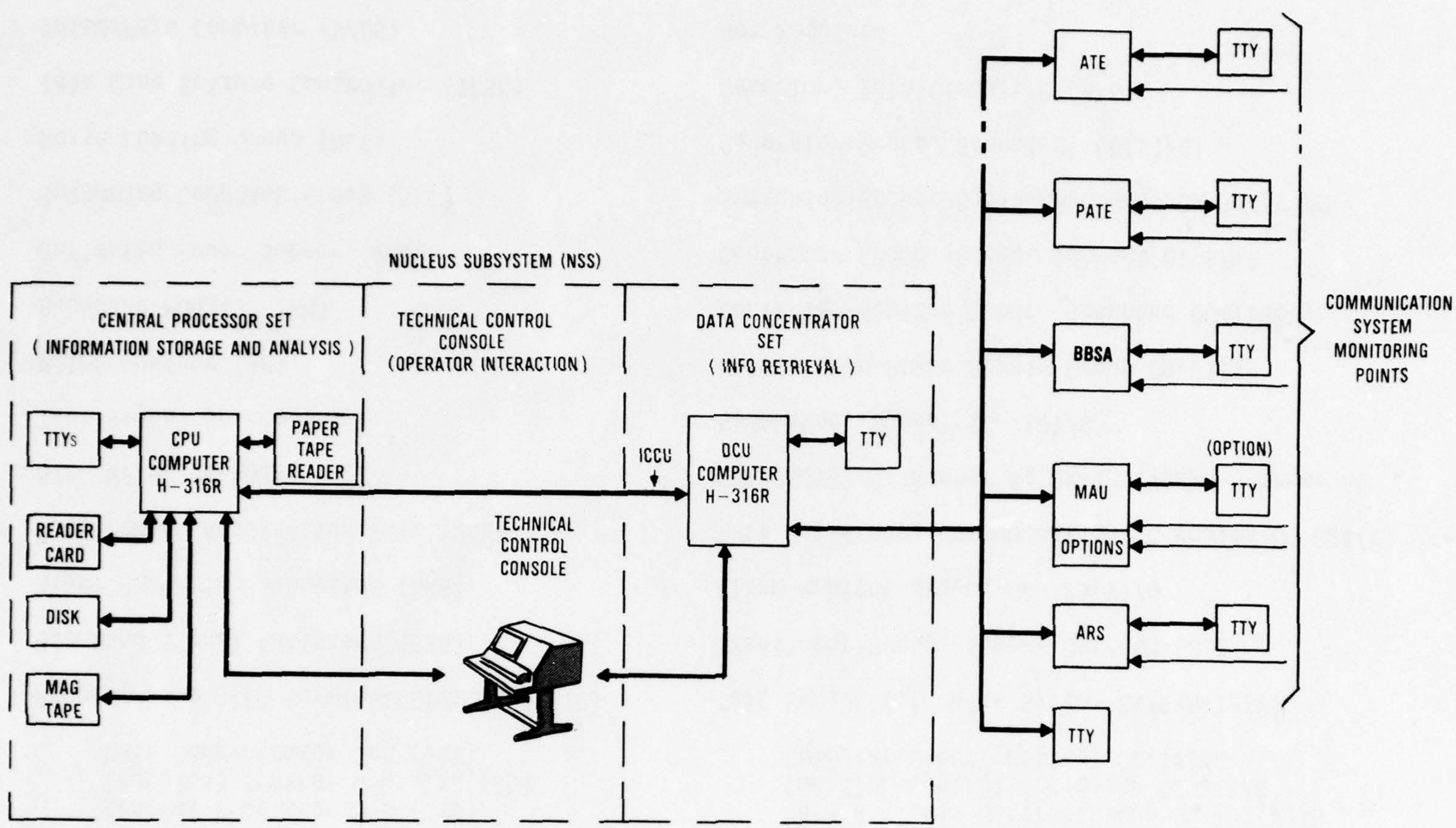


FIGURE 2-1. CPMAS SIMPLIFIED BLOCK DIAGRAM

All input and output communications with the operator is provided via the console. The DCS provides the information acquisition and telemetry with the ATEs. The CPS provides the information storage, retrieval, and analysis function and interfaces directly with the console to permit a rapid transfer and display of data. The interface between the console and the DCS is a lower speed access for discrete command information transfer.

The points where the CPMAS is connected to the communications system are termed monitor points and are connected to the ATE by high impedance scanner circuits to prevent loading or interference with communications traffic flow. An exception to this general provision is required on those particular interactive measurements which require the path to be broken to insert a test signal, provide a loopback, or provide a special termination. These special "out-of-service" tests are procedurally restrained to be executed only at times when traffic is not being passed or when otherwise authorized by a technical controller. In addition to the attachment to the communications system at the monitor points, the CPMAS also interfaces with the communications system to provide communications, control messages, and data flow between the NSS and the remote ATEs.

2.3.2 ATEC Terminal Elements (ATEs).

Also shown in Figure 2-1 are the following ATEs, which are the basic monitor/test subsystems of the CPMAS:

a. Programmable ATEC Terminal Element (PATE). The PATE is a computer controlled, automatic test and evaluation system which performs in-service and out-of-service monitoring, alarm sensing, and trend analysis of digital data, voice frequency (VF) and frequency shift keyed (FSK) communications circuits. The PATE is used within a Technical Control Facility (TCF) to provide performance monitoring of active communications circuits without interference to normal traffic flow. The PATE out-of-service function provides additional capabilities of injecting test tones used for end-to-end and loop test of idle circuits. PATE functions are computer controlled. The computer program can be operated either automatically or as an interrupt program through use of a local input/output (I/O) terminal. Remote control of the PATE is accomplished through the CPMAS Nucleus Subsystem. The choice of local or remote control is selected at the PATE position.

b. Baseband Signal Analyzer (BBSA). The BBSA operates as a high-quality remotely controllable, tunable (12 kHz to 5 MHz), variable bandwidth selective voltmeter. It makes measurements at the baseband interface between frequency division multiplex equipment and the radio or cable system and may also be manually attached to the group and supergroup distribution frames for measurement purposes. Under control of the NSS or local teletypewriter, the BBSA will measure the level of any selected channel in the baseband, group levels, channel carriers, pilots, etc.

In its present concept no direct operator attention is required for normal operation and no front panel controls are provided. The baseband may be scanned to make discrete measurements at specified frequencies or make level measurements across a specified band of frequencies. In one scan mode the BBSA provides a continuous scan of VF bandwidth signals over a range of 12 kHz to 5 MHz. These VF bandwidth signals may be heterodyned to voice frequency for external analysis by a PATE. Also, the BBSA will scan any portion of the 12 kHz to 5 MHz baseband using sweep widths of 50 Hz or 500 Hz.

Level measurements are compared to threshold, reporting only those levels outside of the limits, together with the frequency at which the "out-of-limit" voltage was measured.

The BBSA generates supergroup, group, or VF channel displays which can be monitored by the technical controller on a remotely located conventional oscilloscope.

The BBSA also has the capability to generate and inject single frequency test tones into a baseband for test purposes. The frequency and signal level of these test tones are controlled by the BBSA computer.

c. Alarm Reporting Subsystem (ARS). The ARS is used to monitor the status of different communication equipment alarm functions. It automatically senses, displays, and transmits the status of two-state alarms, such as a switch closure, a relay activation, absence or presence of an ac or dc voltage, etc. The ARS can monitor and display the status of up to 500 alarms, in groups of 50. It can accumulate and display the alarm data locally, or transmit it to the Nucleus Subsystem for inclusion in CPMAS performance assessment or fault isolation procedures.

d. Measurement Acquisition Unit (MAU). The MAU provides automated monitoring of voice frequency signal levels and dc voltages. It permits the acquisition and measurement of analog signals for applications such as in-service monitoring or out-of-service circuit testing. Control of the MAU is provided by an associated I/O terminal which provides hard-copy results of the various measurements and provides the means for operator control through the CPMAS Nucleus Subsystem. The MAU is used by TCF personnel to obtain performance checks of active digital data circuits and VF signal levels without interruption of normal traffic flow.

The MAU is capable of interfacing with and controlling selected equipment options to provide additional monitor/test functions. These options are covered in Section 4, Paragraph 4.6, of this report.

2.3.3 Input/Output (I/O) Terminals

The teletypewriters (TTYs) shown in Figure 2-1 provide the interface between operator personnel and the CPMAS equipments.

The TTYs function as input/output terminals to permit the operator to command and control the NSS and ATEs, obtain hardcopy printouts, and load or dump computer programs. The TTYs also provide for orderwire communications among operators at remote facilities.

During the development of the CPMAS the I/O function was fulfilled by the Teletype Corporation Model 37 Automatic Send-Receive (ASR) Set (military nomenclatured as Teletypewriter Set AN/UGC-110). Due to the non-availability of ASR-37s for use with the initial production equipments coupled with the need to reduce downtime maintenance, a suitable I/O terminal replacement was sought and the General Electric Model 1200B TermiNet was selected. The TermiNet 1200B, in the ASR configuration, retains all functions accomplished by the ASR-37.

2.3.4 Equipment Modularity.

In order to accommodate the many different TCF configurations and the wide variation in equipment complexity, the CPMAS family was developed with a high degree of modularity and deployment flexibility. As previously stated, a simple configuration could exist with one or more SAEs operating alone and without the coordinating activity of an NSS. A lower echelon of modularity is provided within the SAE, each containing options which may be added or deleted to accommodate a particular application.

When the area to be serviced by a CPMAS installation becomes sufficiently large and includes several TCFs, an NSS will be used as a central coordinating element. The NSS is also modular in design, allowing cost effective employment in small systems as well as in larger system configurations. The most visible element of modularity is the operator's interface, which is provided by the console. In small systems, a single operator's console can provide all the output information to the operator(s) and accept all operator inputs. In the larger system applications, several consoles (up to a maximum of six) can be utilized with certain consoles dedicated exclusively to assigned system functions. As an example, a medium sized installation might contain one Performance Assessment Console, one Coordinator's Console, and one Reporter's Console. The NSS hardware provides further flexibility by providing expansion of the data base storage for larger systems, or adding additional communications ports when more than 64 full duplex lines to ATEs or consoles must be provided (128 full-duplex maximum).

2.4 SYSTEM OPERATION

In an operational CPMAS, the initialization and control of the CPMAS primary functions is performed by the Nucleus Subsystem (NSS). However, when the NSS interfaces with the PATE, a portion of the acquisition and analysis function is handled by the PATE minicomputer. The PATE is capable of performing its own scan sequences, alarm threshold comparison, and executing trend algorithms.

The Measurement Acquisition Unit (MAU) and its options, Alarm Reporting Subsystem (ARS), and the Baseband Signal Analyzer (BBSA) require commands from the NSS for operational control. The NSS sends commands to both the MAU and the BBSA to maintain predefined measurement modes for data collection. The BBSA, in the background scan mode, is provided threshold limits by the NSS for purposes of parameter comparison and where necessary, alarming. Only "red" alarm conditions are identified to the NSS. The NSS sends all commands to the MAU for its background scan mode, collects all the measured data and compares it against specified limits contained in the NSS software. Alarms from the MAU background scan are generated by the NSS.

The information gathered as a result of ATE background scans can be displayed on the Technical Control Console CRT display. The NSS operator is continuously kept informed of the communications system status and is provided control of the measurement capabilities of the CPMAS through the comprehensive CRT displays. Particular requirements of testing, such as entering new equipments into a predetermined background scan, performance of routine tests, requests for demand tests, and the performance of special tests, are all accomplished through the use of master test sequences which are predefined and stored in the software data base.

2.4.1 Background Monitor Mode.

The background mode for each ATE is considered to be the normal noninterfering monitoring mode for gathering the bulk of information required for performance assessment. The ATEs normally function in their background modes except during the performance of time dependent tests, demand tests or special tests as directed by the NSS. The background mode (normal scan) is defined in each ATE's data base. ATEs are placed in their background scan mode after initialization.

2.4.2 Routine Monitoring Mode.

Routine monitoring modes are those measurements which are performed on a time dependent basis. Commands for this mode are issued by the NSS to the ATE of interest. Types of measurements which may fall into the routine monitoring category are:

a. Out-of-service testing of VF-to-VF links on a periodic basis during known periods of low, or no, activity.

b. Measurements on equipment links or circuits to collect trend and historical data.

c. Measurements of channel magnitudes during known periods of maximum loading to detect "hot" channels.

In general, routine measurements can be defined for any parameter which must be observed on a time dependent basis. The relative priority of a routine measurement is higher than background but lower than a demand measurement, therefore, routine tests will interrupt the normal background scan and will be performed unless the NSS interrupts with a demand test. If the routine measurement is not completed prior to interruption the NSS will return to this test if it can be completed prior to its next scheduled time, otherwise it will be skipped until its next scheduled time. Routine measurements are activated by the use of test selector/activator displays which contain the time dependent test type selection.

2.4.3 Demand Tests.

Demand tests are initiated by operator request and are executed immediately. Demand tests are utilized by the console operator to obtain specific monitor point data, both in and out-of-service. These tests are used to aid in troubleshooting, fault isolation, and verification of cleared troubles. Any test sequence may be designated as a Demand Test. Demand tests may include:

a. FSK subchannel level measurements.

b. VF circuit out-of-service tests.

c. VF channel level in-service measurements.

d. TCF equipment DC voltage measurements.

e. Group level measurements within a Supergroup.

f. Channel level measurements within a Group.

g. Multiplexer pilot phase jitter measurements.

h. Baseband noise slot measurements.

i. Link Voltage Standing Wave Ratio (VSWR) measurements.

2.4.4 Special Tests.

Special tests are made up of routine tests, demand tests, or a combination of both. Tests that are complex but are used frequently by the system are placed in the category of special tests. Any special test is defined as a master test sequence applicable to a specific point and is listed in the Special Test Directory.

2.4.5 Associative Tests

Associative tests are predefined test sequences that are initiated as a result of alarm conditions detected by normal background scan. These tests are selectively enabled on an individual equipment and circuit basis by specific data bits in the NSS operational program. These tests, which represent the first step in fault isolation under control of the Nucleus Subsystem, are initiated in the following instances:

a. Upon receipt of a valid change in a communications measurement parameter alarm state.

b. Upon receipt of a confirmed degrading trend from "green" toward "amber" or "red".

Automatically initiated associative tests are of five basic types. Refer to Table 2-3. The associative testing procedure consists of a transverse and/or longitudinal test, and acquisition of appropriate related equipment alarms. After the required data has been accumulated, it is formatted and presented to the operator as part of an Activity Message. The NSS operator may activate associative test routines when additional information is required during manually initiated performance assessment or fault isolation activities. The Trouble Ticket format, presented on the CRT, provides an entry to initiate the appropriate associative test. Within the data base, provisions are made to either enable or disable the automatic initiation of associative tests. Associative tests will be disabled when an ATE is initially brought into service, when circuits are being added (major reconfiguration), or when there is a particularly troublesome circuit on which additional testing is not desired.

TABLE 2-3. ASSOCIATIVE TESTS - FIVE BASIC TYPES

Communications System Entity	Identifier	Station Wring Out			Longitudinal Analysis
		Transverse Analysis	Hierarchical Analysis	Equipment Alarms	
VF Channel	Circuit CCSD* and Direction	Other VF channels in same group, measured by comparable equipment from which alarm was received.	Group level and/ or pilot measurement from BBSA (if available).	Any that are explicit to the CCSD or its group in the same station where alarm was originated.	Other station appearances at the VF channel level of the same CCSD upstream in the signal flow sense.
FSK Subchannel	Circuit CCSD and and Direction	Other FSK subchannels in the same VFCT measured by same MSMS.	VF channel carrying faulty FSK subchannel.	None.	Other appearances upstream as a DC Circuit or FSK subchannel (DDMS or MSMS measurement).
DC Channel (Data)	Circuit CCSD	Measure VF channel carrying Data Circuit and other VF channels in same group, just as in VF channel case.	Like VF channel.	Any explicit to the CCSD.	Other station appearances of the DC channel or its VF channel, upstream in the signal flow sense.
FDM Group	Trunk Identifier and Direction	Measure level, pilots in other groups in same supergroup by BBSA.	Measure Baseband level and examine baseband pilots using BBSA and/or BM.	Acquire those associated with the group/Trunk ID.	Measure or acquire group level and/or alarm info from same trunk ID upstream from fault.
FDM Baseband	Link ID and Direction	None.	None.	Acquire those associated with the Link ID.	Measure or acquire Base band info upstream as far as Baseband is contiguous (i.e., as far as Link ID remains unchanged or Baseband is not broken down - just repeated).

* Command Communications Service Designator

SECTION 3

NUCLEUS SUBSYSTEM DESCRIPTION

3.1 GENERAL

The NSS is a data processing unit made up of a Central Processor Set and a Data Concentrator Set (Figure 3-1). A man/machine interface unit, the Technical Control Console (TCC) (Figure 3-2) is a peripheral equipment used with the processing units. A teletype communications terminal device option can also be used in conjunction with the NSS as part of the operator's station. Its primary function is to provide a capability allowing the operator to obtain a permanent printed copy of any displayed data that he may require and to selectively communicate with any remote ATE TTY.

The processing unit accepts inputs from many ATEs (up to 64) and presents the coordinated results to an operator for further analysis. Each ATE:

a. Provides inputs that are automatically coordinated with other ATE inputs by the NSS.

b. Performs tests in concert with other ATEs as commanded by the NSS.

c. Performs special tests both automatically and on NSS demand to aid in system fault isolation.

d. Provides NSS specially requested data to permit statistical analysis of system problems.

Many of the coordinated measurements are made automatically through specialized system software used in the processing unit. Upon request, monitored results from any ATE can be presented to an operator at the TCC for use in directing further performance assessment actions.

A simplified block diagram of the Nucleus Subsystem is shown in Figure 3-3. The Central Processor Set (CPS)/Data Concentrator Set (DCS) combination is a dual processor configuration, using two Honeywell Model H-316R computers. The DCS computer provides the serial-to-parallel and parallel-to-serial data translation required for the Central Processor to communicate with the ATEs. The interface between the Data Concentrator Set and Central Processor Set is via a Honeywell standard Intercomputer Communication Unit (ICCU) which permits a high speed data transfer using the Direct Multiplex Control (DMC) option of the H-316R. One of the basic functions provided by the Nucleus Subsystem is storage of the

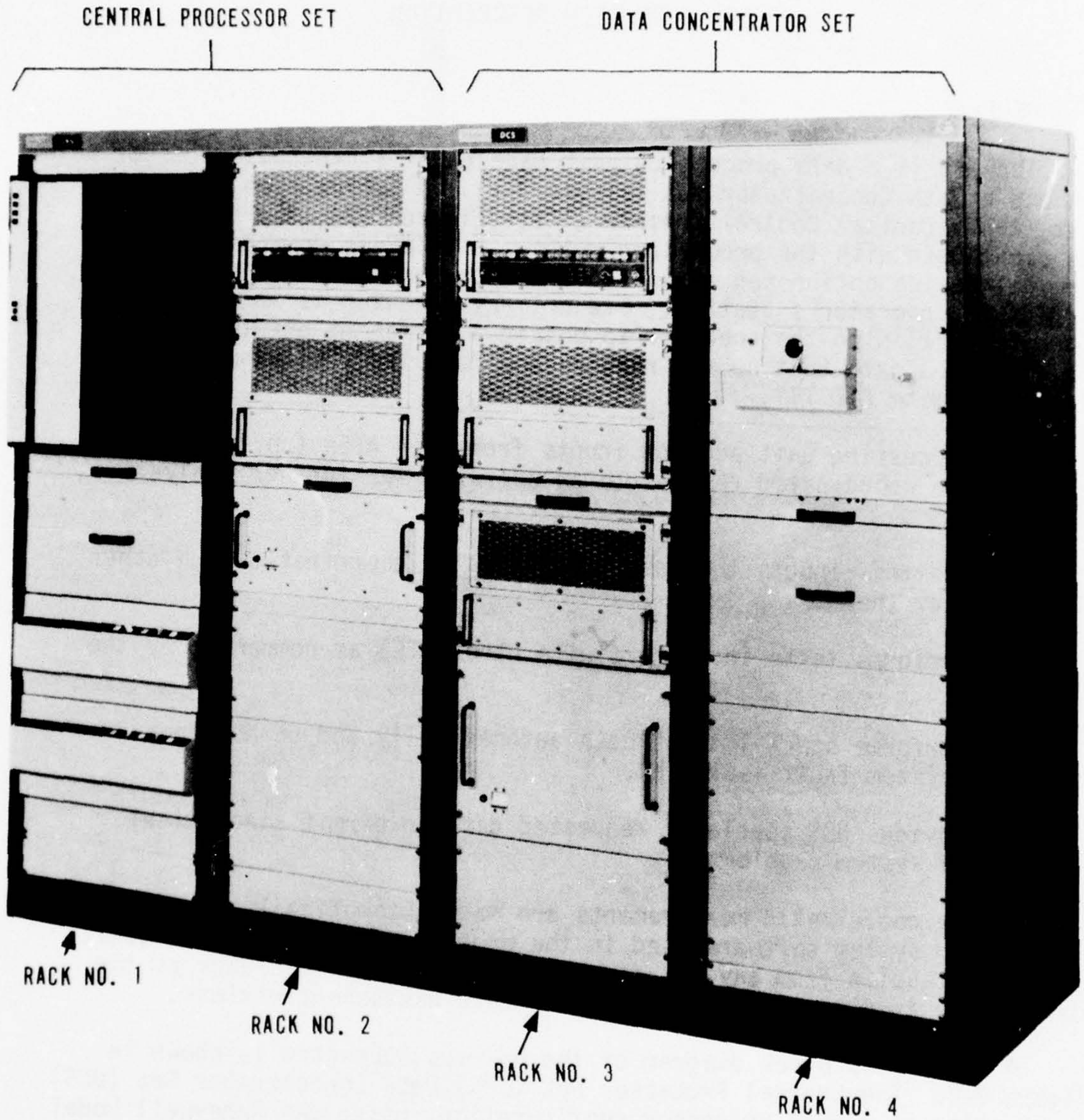
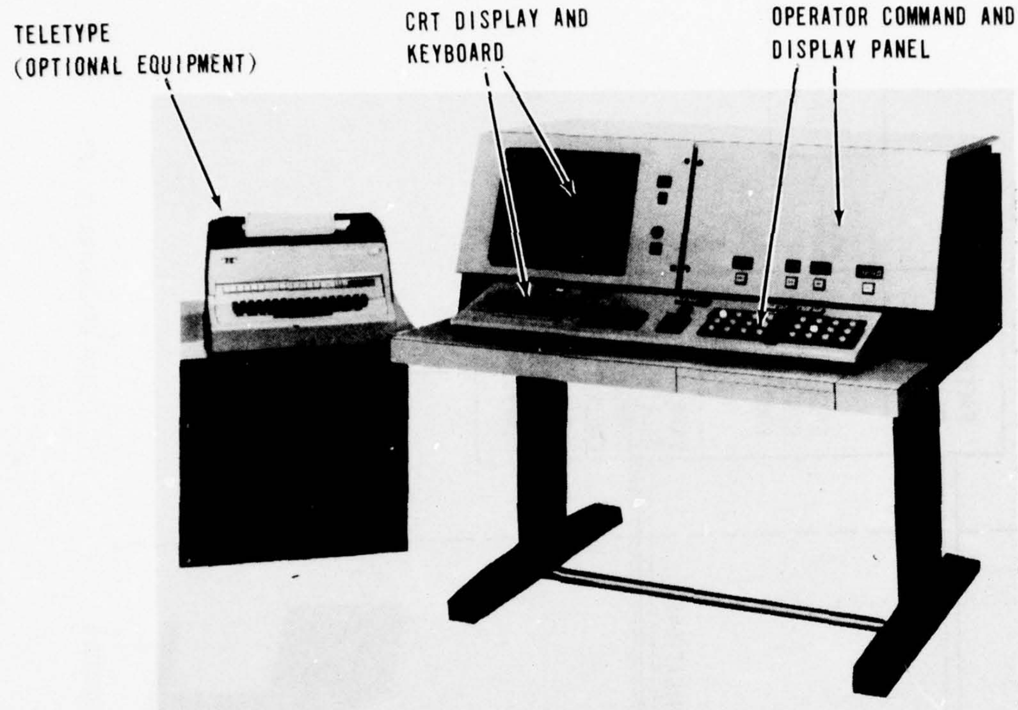
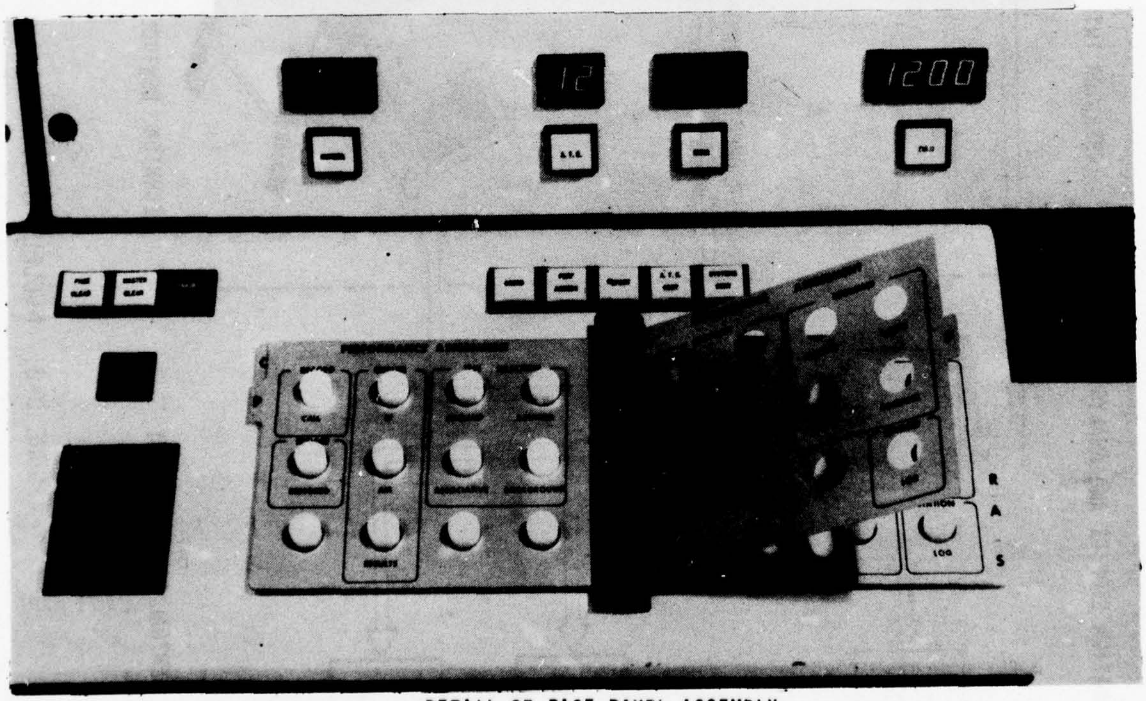


FIGURE 3-1. NUCLEUS SUBSYSTEM CONFIGURATION





DETAIL OF PAGE PANEL ASSEMBLY

FIGURE 3-2. TECHNICAL CONTROL CONSOLE

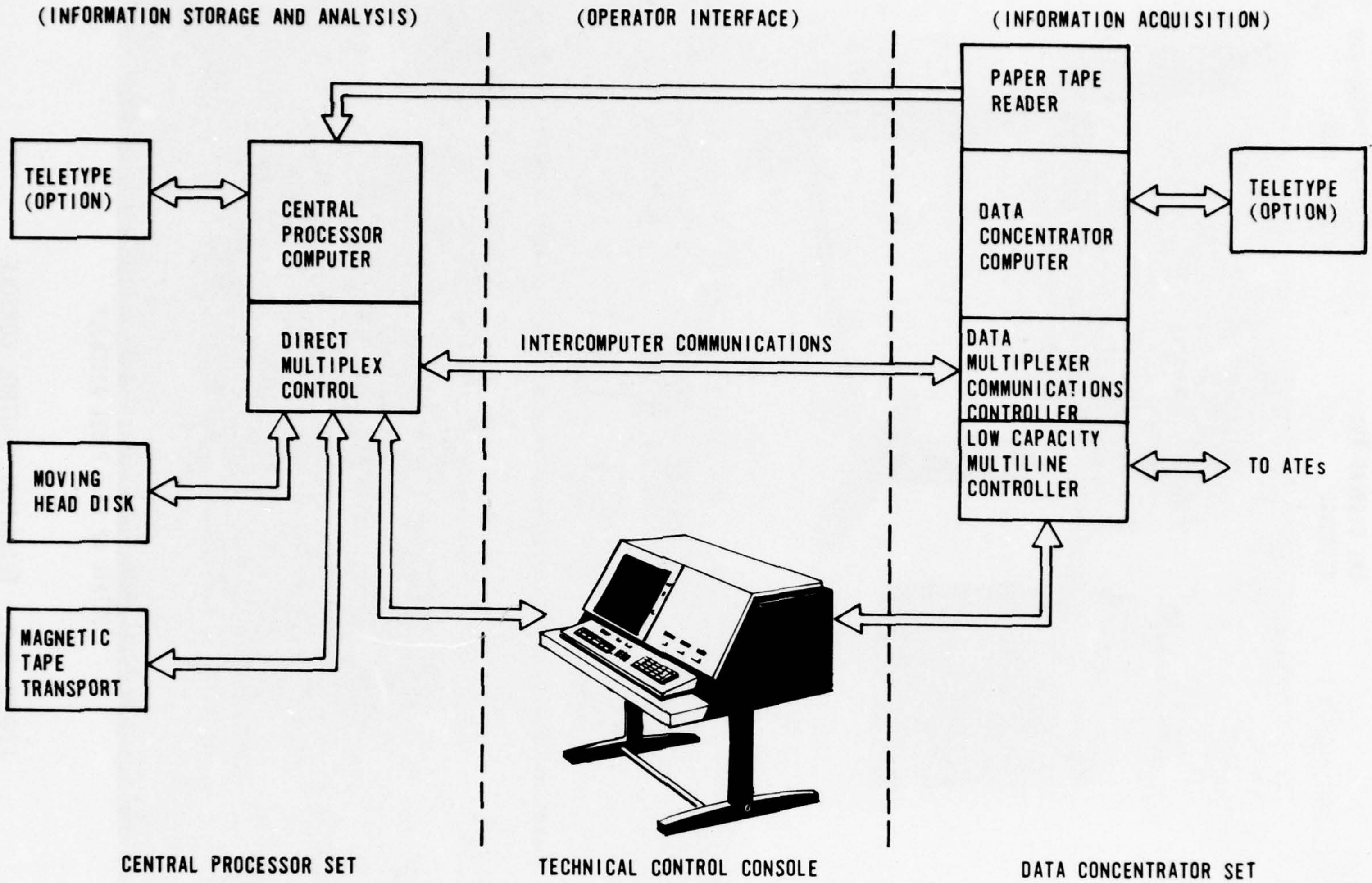


FIGURE 3-3. NUCLEUS SUBSYSTEM - SIMPLIFIED BLOCK DIAGRAM

system data base which associates the ATE monitor points to each other and to the physical organization of the communications network which is monitored. This accessible data base permits the system to coordinate many ATEs and monitor points for the purpose of rapid fault isolation. This large data base is stored on disks with a second backup storage facility, magnetic tapes, also provided as part of the Central Processor Set. Magnetic tape storage is used primarily for collection of historical data (used for off-line statistical analysis) and for recovery in case of disk unit failure. The prime man/machine interface is located at the Technical Control Console, CRT Terminal and Page Panel Control (PPC). The PPC is a set of illuminated pushbutton switches whose functions are determined by the position of cams, operated by a group of overlay boards with the appropriate functional labels engraved on them.

3.2 PHYSICAL DATA

The physical characteristics of the NSS equipments are given in Table 3-1.

3.3 NUCLEUS SUBSYSTEM OPERATION

The effectiveness of the Nucleus Subsystem operation depends upon the efficiency of the man-to-machine relationship. A single console configuration serves in several different job functions. Regardless of the function, the principle operating interface is through the CRT terminal. System data is presented to the operator in concise visual displays which provide a checklist for possible operator actions. The operator takes appropriate action then returns the display data back to the CPS computer where the input is interpreted and executed. The CRT display also provides a feedback system for spontaneous messages from procedural errors, alarm messages and other operational reminders. A keyboard printer (teletype) option can be included as part of the operator's station. Its primary function is to provide a print capability allowing the operator to obtain a permanent hard copy of any CRT display that he may require. When the operator desires a specific operation to be executed or a new display to be presented on the CRT, he can select the desired action by depressing a labeled push-button on a page panel. The page panel consists of a set of push-buttons which are labeled "pages" that overlay the pushbutton matrix. When the labels are changed by placing a new page in position, a microswitch closure identifies to the processor which page is in position. The various pages are organized according to the desired operational responsibility.

The Nucleus Subsystem test activity is initiated by either a communications user complaint or by a message from an ATE that has measured an abnormal situation. In the first case, a Trouble Ticket is generated by the operator, using the console controls; in the second, the NSS automatically generates an Activity Message in response

TABLE 3-1. PHYSICAL DATA-NUCLEUS SUBSYSTEM EQUIPMENT

CENTRAL PROCESSOR SET

Dimensions	(Given in inches, Height x Width x Depth)	
	Equipment Rack (two used)	72.00 x 22.00 x 30.00
	Mainframe Drawer	12.25 x 19.00 x 24.25
	H-326R Option Drawer	12.25 x 19.00 x 24.25
	Peripheral Control Drawer	10.00 x 19.00 x 24.00
	Disk Drive Unit	8.72 x 19.00 x 28.00 (30.06 overall depth)
	Magnetic Tape Transport	24.00 x 19.00 x 16.25
Weight	700 pounds	
Power Requirements	Primary ac: 117 (± 10%) Vac, Single phase, 47.5 to 63 Hz, 3 wire	
	dc: H-316R computer and options - self contained. Other - +5Vdc at 16 amps, supplied by LAMBDA Power Supply Model LX5-CC-5-OVR located in Peripheral Control Drawer.	
Cabling Requirements	External cabling: site dependent. Internal rack cabling: furnished.	

DATA CONCENTRATOR SET

Dimensions	(Given in inches, Height x Width x Depth)	
	Equipment Rack (two used)	72.00 x 22.00 x 30.00
	Mainframe Drawer	12.25 x 19.00 x 24.25
	First Option Drawer	12.15 x 19.00 x 24.25
	Second Option Drawer	12.15 x 19.00 x 24.25
	Communications Interface Unit	20.00 x 19.00 x 24.00
	Paper Tape Reader	17.25 x 19.00 x 25.70
Weight	550 pounds	

TABLE 3-1. PHYSICAL DATA-NUCLEUS SUBSYSTEM EQUIPMENT (CONT.)

DATA CONCENTRATOR SET (Cont.)

Power Requirements	Primary ac:	117 (± 10%) Vac, single phase, 47.5 to 63 Hz, 3 wire.
	dc:	H-316R computer and options - self contained. Other - ±12Vdc at 3 amps each, supplied by LAMBDA Power Supply Model LXD-CC-5-152R with LM-OV-2 overvoltage protection option. Located in Communications Interface Unit.
Cabling Requirements	External cabling: site dependent. Internal rack cabling: furnished.	

TECHNICAL CONTROL CONSOLE

Dimensions	(Given in inches, Height x Width x Depth)	
	Console Structure	45.00 x 48.00 x 39.50
	CRT Display Terminal	17.15 x 21.00 x 27.50
	Operator Command and Display Panel	4.50 x 39.00 x 9.00
Weight	500 pounds	
Power Requirements	Primary ac: 117 (± 10%) Vac, single phase, 47.5 to 63 Hz, 3 wire.	
	dc: CRT Display Terminal - self contained. Console Electronics - +5 Vdc at 9 amps, supplied by LAMBDA Power Supply Model LXS-CC-5-OVR. ±12Vdc at 16 amps, supplied by LAMBDA Power Supply Model LXD-CC-5-152R with LM-OV-2 overvoltage protection option.	
Cabling Requirements	External cabling: site dependent. Internal rack cabling: furnished.	

to the ATE alarm. If the number of input Activity Messages generated ever exceeds the capability of the NSS operators to handle them on a timely basis, the system is programmed to begin channeling the less important problem statements to the ATE operators at the remote Technical Control Facilities (TCFs). At any given time, the backlog of activity can be determined from one of the CRT summary displays as requested by the operator, or from the number of unresolved Activity Messages shown on a numerical readout with an accompanying indicator showing the highest priority contained in the backlog. A numerical display is also provided to indicate current time of day as calculated from a precision oscillator located in the CPS. A ten digit keyboard is provided to facilitate entering numbers in two other displays when certain numerically related commands are executed from a page panel.

3.4 CENTRAL PROCESSOR SET DESCRIPTION

The Central Processor Set (CPS) contains the system operational programs, stores all fixed data required for system operation, and connects information from the various ATEs via the Data Concentrator Set. The CPS performs analysis on collected information, correlates results of tests, and provides alarms, status, and command information for subsequent transmission and display. The CPS, operating as part of the NSS, functions as follows:

a. Contains and executes the System Executive programs.

b. Stores fixed data required for system operation.

c. Collects and stores information from system monitoring devices.

d. Performs analysis of received information and compares results with stored standards.

e. Correlates results and translates information into a form usable to the operator.

f. Provides for transmission of status and command information to the CRT display terminal and teletypewriter under operator control.

g. Issues alarm signals to the CRT Display Terminal as established by system operating requirements.

h. Communicates with the Data Concentrator Set via the Intercomputer Communications Unit (ICCU).

Refer to Figure 3-4 for a block diagram of the Central Processor Set.

The CPS is made up of three types of equipment: the computer with its options, the peripherals, and the Peripheral Control Unit. The hardware is mounted in three of the four equipment racks (Figure 3-1).

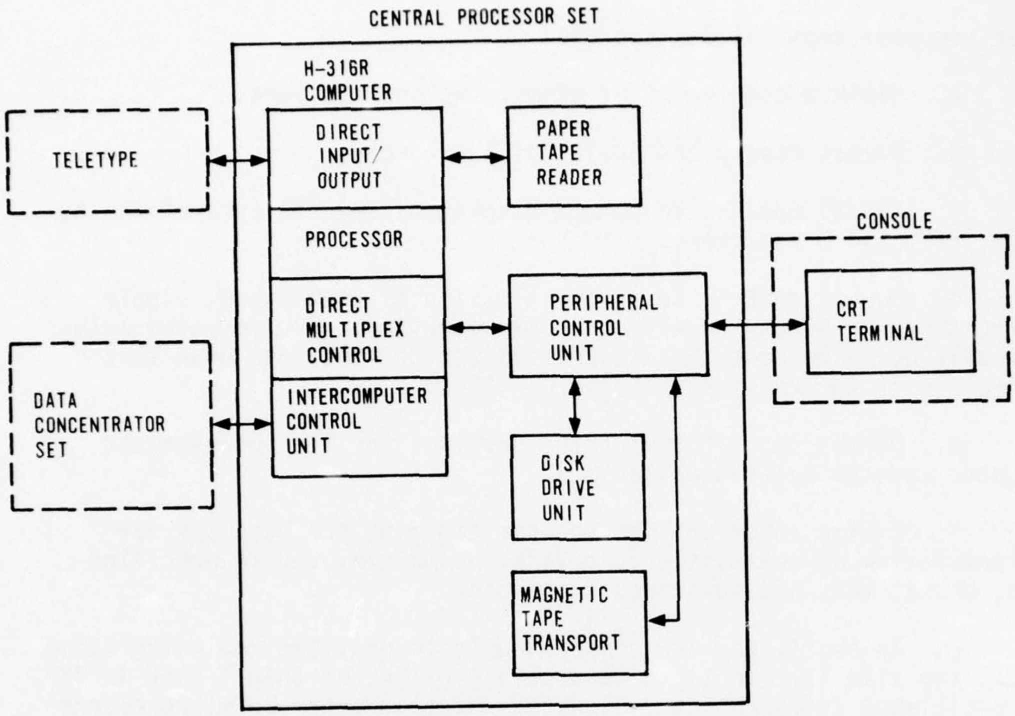


FIGURE 3-4. CENTRAL PROCESSOR SET - BLOCK DIAGRAM

Rack No. 1 contains the Magnetic Tape Transport and the two Disk Drive Units. Rack No. 2 contains the CPS Computer Mainframe Drawer, the Computer Option Drawer, and the Peripheral Control Unit. Rack No. 4 contains the Paper Tape Reader. Rack No. 4 is physically a part of the Data Concentrator Set, however, the Paper Tape Reader functions only with the CPS.

3.4.1 H-316R Computer and Options.

The CPS Mainframe Drawer houses the Honeywell H-316R Computer and standard H-316R options, including the power supply for all equipment within the drawer. The H-316R is a ruggedized version of the H-316 General Purpose Computer. The H-316R is electronically identical to the standard H-316, but the enclosure, power supply, control panel, cooling fans and external cabling have been redesigned to ensure reliable operation under extreme environmental conditions. The computer is a solid-state, internally stored program, general purpose digital computer organized as a parallel, 16-bit machine with a machine code of two's complement. The memory cycle time is 1.6 microseconds with memory supplied in modules of 4,096 words each, with a total storage of 32,768 words. Indexing, Base Sector Relocation, and Multilevel Indirect Addressing is also provided. The memory is four-wire, coincident-current, magnetic core.

Other computer capabilities include:

a. Minimum complement of eighty-two instructions.

b. Direct memory addressing of 1,024 words.

c. Manual control to permit display of the contents of the A, B, OP, P/Y, and M registers.

d. Manual control to allow selection of continuous, single instruction, or memory access modes of operation. The computer automatically performs power on and initialization functions when this control is in the run (continuous) position.

e. Direct Input/Output (DIO) provides the link between the computer and the teletypewriter.

f. A high speed arithmetic unit contains the hardware for implementation of the multiply, divide, normalize, double precision load, store, add, and substract functions.

g. An oscillator and associated logic provides real-time (time of day and time increment) to an accuracy of better than 1 part in 10^6. The oscillator increments a designated location every 20 microseconds in memory which causes an interrupt to occur when an overflow is tallied (program selectable). The memory cell location can be preset under program control or can be interrogated to determine finer time increments than that established by the interrupt period.

h. Input/Output (I/O) of data is word parallel via the I/O bus by program control of the Direct Multiplex Control (DMC) unit. The capability of connecting up to twenty individually addressable channels to the I/O bus also exists. An I/O Bus Control Unit required to drive the I/O bus to the Intercomputer Control Unit (ICCU) in the CPS is also provided. The computer contains the following I/O lines: 10-bit address bus, 16-bit input bus, 16-bit output bus, standard interrupt, and control lines. The control lines are: Data Ready, Output Control Pulse, Master Clear, Program Interrupt, Set Interrupt Mask, Clear Interrupt Mask, Reset Ready Line, and End of Range.

(1) I/O Modes. The CPS has three basic modes of data transfer between the computer and peripheral devices; single-word transfer without priority interrupt, single-word transfer with priority interrupt, and DMC channel block transfer.

(2) Interrupts. A standard interrupt is provided which causes a forced instruction at the end of the current instruction through a particular core location. After the interrupt, the program returns to the point at which it was interrupted. Twenty priority interrupts are provided in addition to the standard interrupt.

i. Memory Protect/Lockout. Standard memory protect for the CPS is provided so that if ac line current fails or power is turned off at the operator control panel while the machine is in the run mode, the machine will be interrupted and go to a particular core location to execute power down operations. In no case are the programs and data stored in memory destroyed or altered due to a power failure. The power-fail interrupt is nonblockable and has top priority. The computer contains the necessary logic and circuits that permit the program to automatically resume at location 0000_8 when power is restored. The memory lockout option facilitates the timeshared execution of other programs (such as Display Management) concurrently with on-line operation. Program control is exerted to protect any or all memory sectors. (Protection is provided for 16K of memory.) Thus, the memory sectors containing the on-line program and its data are protected from accidental alteration. This option also provides for the creation of a base sector other than the standard sector zero.

3.4.2 Direct Multiplex Control.

The CPS is configured with Direct Multiplex Control (DMC) logic to effect data transfers independent of program control. A 16 device I/O bus interface with priority control is provided which operates at a 312 kHz word transfer rate. An asynchronous I/O independent of program control, using a variable block length, effects the transfers.

3.4.3 Intercomputer Communications Unit.

The CPS includes circuitry to allow a bidirectional, 16-bit parallel word, data interchange with the Data Concentrator Set. The Intercomputer Communications Unit (ICCU) connects to a DMC subchannel of the CPS and consists of a 16-bit buffer register and control logic. A data path is established and the transfer is designed to operate on an interrupt basis, utilizing necessary priority interrupt lines.

3.4.4 CP Processor Option Drawer No. 1.

The Processor Option Drawer contains the following H-316R Computer optional equipment:

a. Memory Expansion. Required for more than 16K core.

b. Core Memory. 16K additional memory words (providing a total capacity, with the mainframe memory, of 32K).

c. Intercomputer Communications Unit (ICCU). Interfaces the dual processors via their I/O buses. A data buffer located in the ICCU allows one computer to deposit a word to be used by the other computer. The ICCU permits transfer of information between the two computers, which operate in a master/slave relationship.

d. Priority Interrupt (PI). Expands the standard interrupt function (shared interrupt line) to enable the addition of up to 48 optional interrupt lines. (20 PI lines are provided in the CPS configuration.)

e. Paper Tape Reader Interface. Provides link between a Honeywell Model 5003 Paper Tape Reader (PTR) and the Central Processor Set. The PTR is unidirectional and reads eight level tape continuously at a slewing rate of 200 characters per second. The PTR is used for fast loading of operational and diagnostic programs to the computer.

f. Power Supply. Provides all the dc voltages required in the Processor Option Drawer.

3.4.5 Disk Drive Unit.

Two Caelus Model 303/2 Disk Drive Units are used with the CPS. The Disk Drive Units are moving head type drives with 2200 bits-per-inch (BPI) density and each unit has a 2.4 megaword useful storage capacity. This capacity is achieved by two disk packs, one fixed and one removable, of 1.2 megaword storage each. Multiple seeks are performed to minimize total (accumulative) time. Access to any one of the 1.2 megaword disk packs is performed in approximately 110 milliseconds. The disk storage interface is provided by a single controller which permits control and data transfer for up to four Disk Drive Units.

3.4.6 Magnetic Tape Transport.

A Hewlett-Packard Magnetic Tape Transport (MTT), Model 7970B, is used by the CPS for data storage and entry. The MTT has a seven channel, large volume storage capability. Program selectable read/write densities of 200, 556, or 800 characters per second at 25, 37.5, or 45 inches per second are included to permit communications with the CPS computer. The tape transport electronics controls generation and verification of vertical and horizontal parity. Utilization of dual-gap, seven-channel head construction provides "read after write" capabilities. Independent vertical and longitudinal parity checking on each record ensures immediate error detection. Word packing and unpacking is performed in the control unit. Recording formats are compatible with IBM 729 magnetic tape units (or equivalent).

3.4.7 Paper Tape Reader.

The Honeywell Type 5003 Paper Tape Reader (PTR) used in the CPS is a Digitronics Model 2500 equipped to interface with the H-316R computer and is used to load system program into the CPS computer memory. The PTR reads eight level tape continuously at a slewing rate of 300 characters per second. When operated in an asynchronous start/stop mode, the reader is capable of stopping on the next character at the maximum slew rate. All eight data levels are read from the tape to the interface device buffer and transferred to the computer input data bus.

3.4.8 Peripheral Control Unit.

The Peripheral Control Unit contains equipment specifically for use in the ATEC application. The major assemblies in this unit are: the Disk Drive Controller, the Magnetic Tape Control, the CRT Terminal Control, the Input/Output Buffer, and the Power Supply.

3.5 DATA CONCENTRATOR SET DESCRIPTION

The Data Concentrator Set (DCS) provides the data conversion and pre-processing function between the Nucleus Subsystem and the associated ATEs. The Data Concentrator Set, operating as part of the Nucleus Subsystem, functions as follows:

a. Contains and executes the special purpose Data Concentrator Set Programs.

b. Receives and processes communications performance monitoring data from ATEC Terminal Elements (ATEs).

c. Establishes files and queues for data transmission to the Central Processor Set.

d. Receives and responds to operator commands from the Technical Control Console in accordance with system operating requirements.

e. Communicates with remote and local teletypewriters.

f. Issues alarm signals to the console electronics equipment in accordance with system requirements.

g. Communicates with the Central Processor Set via the Inter-computer Communications Unit (ICCU).

Refer to Figure 3-5 for a block diagram of the Data Concentrator Set.

The DCS is made up of two types of equipment: the computer with its options and the Communications Interface Unit. The hardware is mounted in Rack No. 3 of the four equipment racks (refer to Figure 3-1). The terminal blocks which are used for inter-equipment cabling to the Communications Interface Unit are located in the base of Rack No. 4 (the equipment rack containing the paper tape reader).

3.5.1 H-316R Computer and Options.

The DCS Mainframe Drawer houses the Honeywell H-316R Computer and standard H-316R options, including the power supply for all equipment within the drawer. The description of this equipment is the same as that for the Central Processor Set Computer and Options contained in Paragraph 3.4.1.

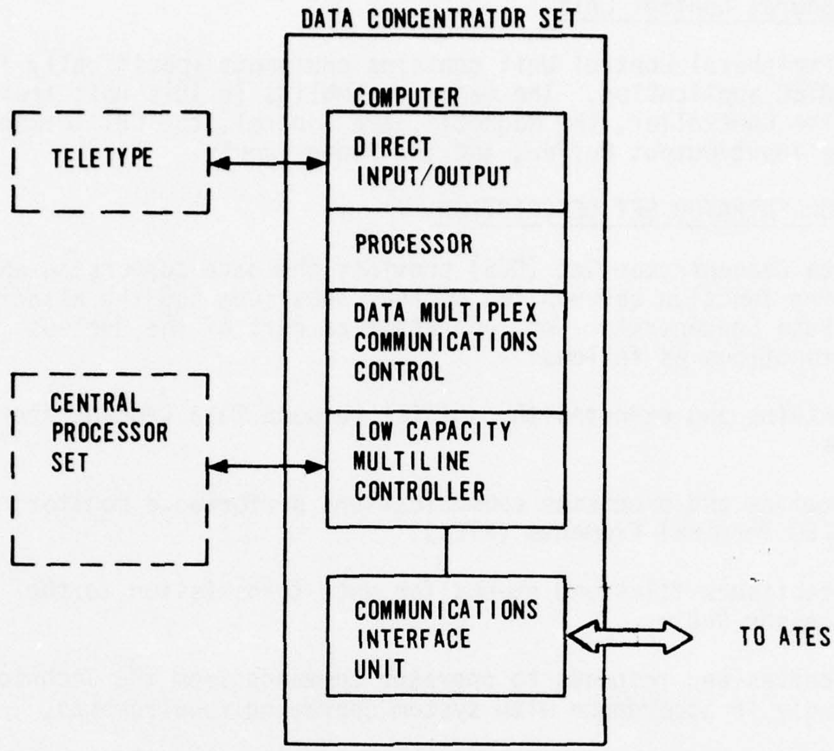


FIGURE 3-5. DATA CONCENTRATOR SET - BLOCK DIAGRAM

3.5.2 Data Multiplex Communications Control.

The DCS is configured with Data Multiplex Communications Control (DMCC) logic to effect data transfers independent of program control. A 16-device I/O bus interface with priority control is provided which operates at a 156 kiloword transfer rate. An asynchronous I/O, independent of program control, using a variable block length, effects the transfers. In addition, it provides a compatible interface with the Low Capacity Multiline Controller (LCMLC).

3.5.3 Line Termination Unit.

A Line Termination Unit (LTU) is provided for each communication line to interface with the LCMLC. The LTU functions to allow the LCMLC to sample the value of the data line in the receive mode or load a bit into an output flip-flop in the transmit mode. No program control is required for operation of the LTU.

3.5.4 Low Capacity Multiline Controller.

The DCS is equipped with a Low Capacity Multiline Controller (LCMLC) to multiplex up to 64 low-speed communications lines into the computer. It provides serial-to-parallel conversion of received line data and parallel-to-serial conversion of transmitted line data. Data transfer to and from the computer is in parallel one character at a time through two computer DMCC subchannels. For each character transferred, not more than four memory cycles are consumed. Hardware parity generation and detection is also provided. The LCMLC is capable of accepting either American Standard Code for Information Interchange (ASCII) or Baudot-coded characters and to simultaneously operate with a mixture of line speeds, preselectable in groups of 4 to 300 baud maximum rate (75, 150 or 300).

3.5.5 DC Processor Option Drawer No. 1.

Option Drawer No. 1 contains the following H-316R Computer optional equipment.

a. Low Capacity Multiline Controller (LCMLC). Interfaces asynchronous Line Termination Units (LTUs) via DMCC to the computer. The LCMLC has 64 full duplex asynchronous communication lines.

b. Multispeed Option. Up to six different speeds (up to 300 baud) may be selected in multiples of four lines for each selected speed.

c. Priority Interrupt. Expands the standard interrupt function (shared interrupt line) to enable the addition of up to 48 optional interrupt lines. (20 PI lines are provided in the CP configuration.)

d. Multicode Option. Enables the LCMLC to operate with groups of LTUs operating with different codes (ASCII and Baudot) simultaneously.

e. Power Supply. Provides all the dc voltages required in the Processor Option Drawer.

3.5.6 DC Processor Option Drawer No. 2.

Option Drawer No. 2 contains the Line Termination Unit (LTU). Each LTU interfaces eight communications lines to the LCMLC and allows temporary storage of data being received or transmitted.

3.5.7 Communications Interface Unit.

The Communications Interface Unit (CIU) contains the interface assemblies specifically for use in the ATEC application. The CIU provides low level interfaces in accordance with MIL-STD-188-100.

3.6 TECHNICAL CONTROL CONSOLE DESCRIPTION

The Technical Control Console (also referred to as the TCC or the console) provides the capability for man-machine interaction between technical control operators and the CPMAS. The Console provides the operator with the ability to obtain alarm, status and fault isolation information; perform command selection and execution; and generate reports. More specifically, the console automatically alerts the operator when actual or potential status changes of significance are detected by the CPMAS monitoring equipment or that a failure occurred in the processor or Data Concentrator Subsystems. It provides for operator call-up of performance details whenever he requires them in a form for use in fault isolation. It also permits the operator the option of receiving requested information in permanent (hard copy) or non-permanent form on the CRT. Controls and data entry means needed for control actions on the CPMAS are provided by the console. Data entry includes the means for inserting narrative-like inputs for reporting purposes, etc. A block diagram of the Technical Control Console is shown in Figure 3-6.

The console performs two distinct functions each of which is performed by a distinct equipment group. These groups are: the Console Electronics and the CRT Terminal (which includes the display group and the keyboard group). These equipment groups are physically housed in one console structure assembly.

The Console Electronics provides for two-way operator communications with the Data Concentrator Set. The Page Panels provide for command entry and visual receipt of information pertaining to Coordinating, Performance Assessment, Reporting, ATEC Terminal Element Control, and System Control according to system operational requirements. The Console Electronics displays the Queue Number, ATE Number, Channel Number, and Zulu Time. The operator can change these numbers using the ten-digit keyboard. The displays provide information such as message priority, number of messages, and other queue information as required during system operation. The console also contains alarm and error indicators to alert the operator of NSS malfunctions. The Console Electronics is housed in the right side of the console structure and also contains three LAMBDA dc power supplies for operation of the console equipment.

The CRT Display Terminal is housed in the left side of the console and contains a Computek Model 250 Display Terminal with a Ball Brothers Model TV-15 Television Monitor. The Display Terminal has self-contained power supplies. The CRT Display Terminal provides for two-way (half-duplex) operator communications with the Central Processor Set according to the system programs contained in the CPS. The operator can enter or display data pertaining to communications performance according to the system's requirements. The keyboard and display are equipped for all ASCII characters, plus some additional special functions.

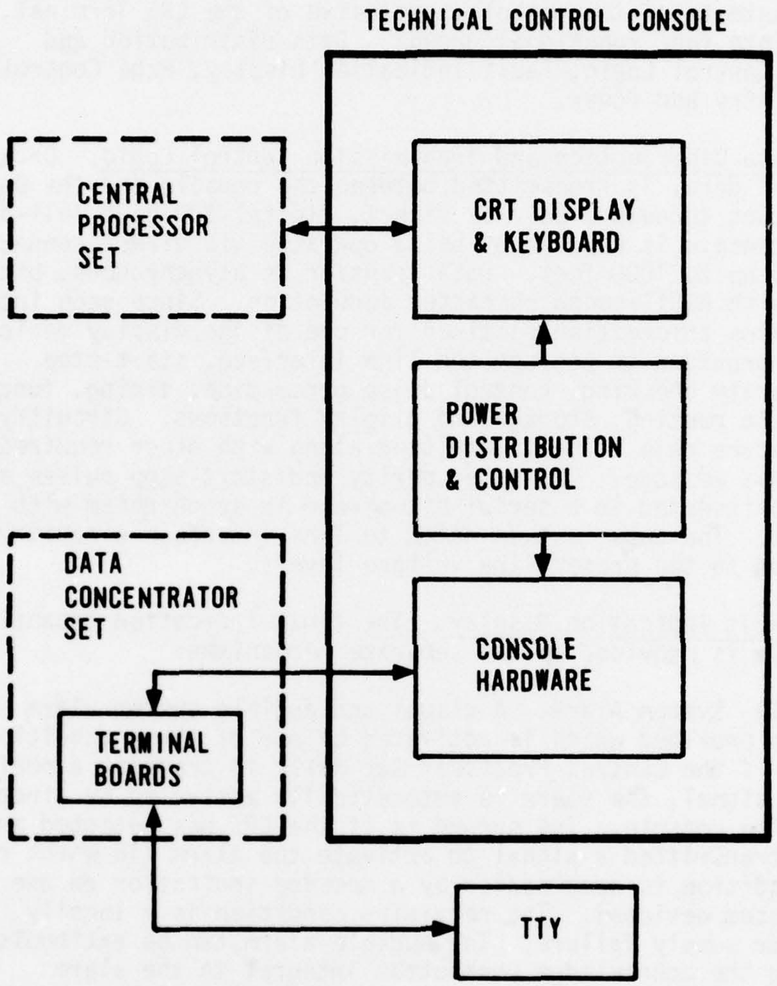


FIGURE 3-6. TECHNICAL CONTROL CONSOLE - BLOCK DIAGRAM

3.6.1 Console Electronics Description

The contents of the console, exclusive of the CRT Terminal, are divided into four functional groups: Data Distribution and Transmission Control Logic, Fault Indication Display, Page Control and Decimal Entry and Power.

a. Data Distribution and Transmission Control Logic. Data, other than CRT data, is transmitted between the console and the Data Concentrator Set through a pair of direct, digital 300 baud full-duplex lines. The console is capable of being operated via direct connection for distances up to 1000 feet. Data transfer is asynchronous, bit-serial data with ASCII-coded character modulation. Since each incoming message contains information destined for one of the display devices, circuitry is provided to perform the line interface, start-stop detection, parity checking, control pulse generation, timing, function ID decode, data routing, storage and display functions. Circuitry is provided to store data to be transmitted along with other required characters in a message. Character parity and start-stop pulses are generated and inserted in a serial bit stream in synchronism with a 300 bps clock. The data is then gated to line interface circuitry, for conversion to the proper line voltage levels.

b. Fault Indication Display. The fault indication capability of the console is provided by two separate mechanisms:

(1) System Alarm. A visual and audible system alarm indication is provided which is activated by one of three conditions. The first is if the Central Processor Set fails to transmit a periodic "keep alive" signal, the alarm is automatically activated by circuits internal to the console. The second is if the CPS has detected an anomaly and transmitted a signal to activate the alarm (in which case the alarm condition is accompanied by a message indication on one of the other system devices). The remaining condition is a locally detected power supply failure. The audible alarm can be extinguished by depressing the acknowledge pushbutton integral to the alarm indicator. The audible alarm contains a volume control and on/off control.

(2) CPMAS Message Summary. A one-decimal digit indicator is used to indicate the highest priority Activity Message contained in the Activity Message Queue. Another two-digit indicator displays the total number of Activity Messages that have been generated and are awaiting operator interaction.

c. Paged Control and Decimal Entry. The Paged Control and Decimal Entry portion of the console consists of an array of pushbuttons which are used for command inputs to provide the Central Processor Set with a wide variety of requests/responses. As an example, if the operator wishes a display of the current Station Log, he will use the paged control for commanding such information to be output by the system processor. A particular pushbutton and page panel combination will produce such a command to the processor.

The decimal entry control can also be used to further identify some types of requests. The functions provided by the individual control pushbuttons are identified on separate hinged overlay page panels. The particular set of functions applicable at any given time is dependent on which particular overlay page panel is in position over the array of pushbuttons. There are four different page panels used in the current NSS configuration: COORDINATING (Figure 3-7); PERFORMANCE ASSESSMENT (Figure 3-8); REPORTING (Figure 3-9): and SYSTEM CONTROL (Figure 3-10). Each overlay page is identified by a unique address during command encoding to identify to the Central Processor Set which page is in position. The control panel is expandable in function by the addition of labels over unused pushbuttons and corresponding assignments in software. A quantity of 120 separate control entries is possible (e.g., by means of 24 pushbuttons and five overlay page panels). An indicator is provided within each of the 24 pushbuttons. As one or more of the pushbuttons is depressed, the information is loaded into the command encoding logic and corresponding indicators are lighted. A Decimal Entry Keyboard (ten-digit) is provided in conjunction with the paged control on the same panel in order to enter numerical information. Decimal readouts are provided for display of entered and received data. The readouts consist of four digits for display of real time hours and minutes (or for initializing the processor real time clock), and three other numerical displays of two, three, and three digits respectively for entry of various system parameters. As the ten digit keyboard pushbuttons are depressed, digits are loaded starting at the most significant digit followed by succeedingly lower decades, for whatever readout is enabled. A readout is enabled for entry of digits by operating the lighted pushbutton located beneath it. When all desired selections have been made, a SEND pushbutton is depressed to transmit the message to the Central Processor Set. A Master Clear pushbutton is provided to clear the page indicators and digit displays. A Page Clear pushbutton is provided to clear only the page indicators. Page Activity pushbutton/indicators are provided to alert the operator to the presence of a computer generated indication on the associated page of the paged control panel. These indicators are resettable by operating the pushbutton.

d. Power Control. An accessible Power Control Panel is located behind the console left rear door. The following equipment is mounted on the panel:

(1) Circuit breakers for primary power to the console logic and CRT Terminal (CRT).

(2) Panel meter for measurement of dc voltages.

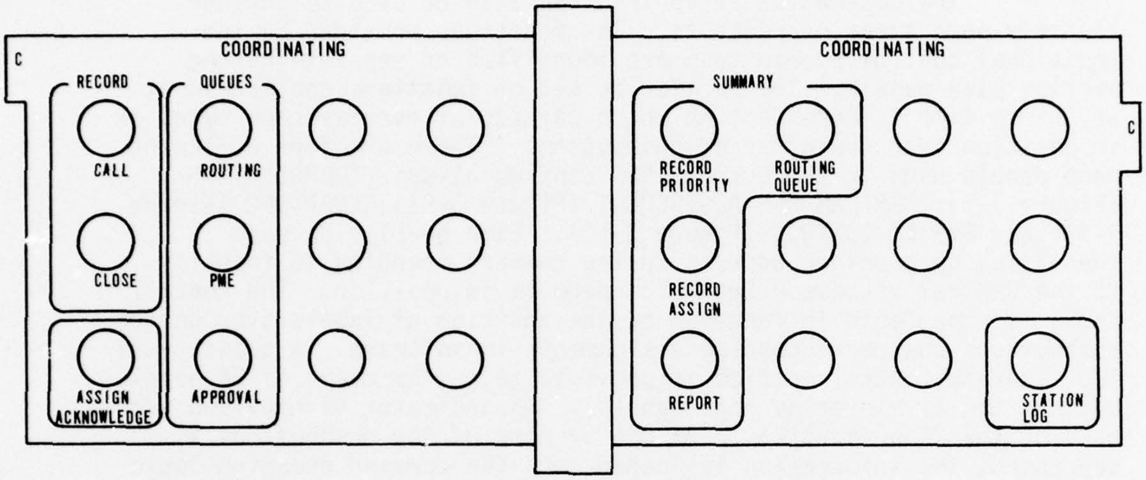


FIGURE 3-7. COORDINATING PAGE PANEL

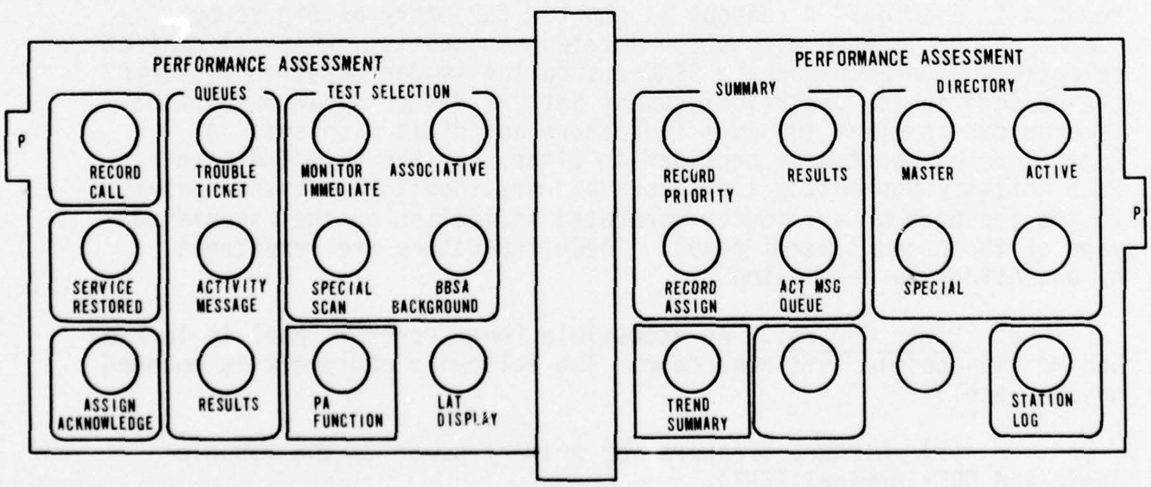


FIGURE 3-8. PERFORMANCE ASSESSMENT PAGE PANEL

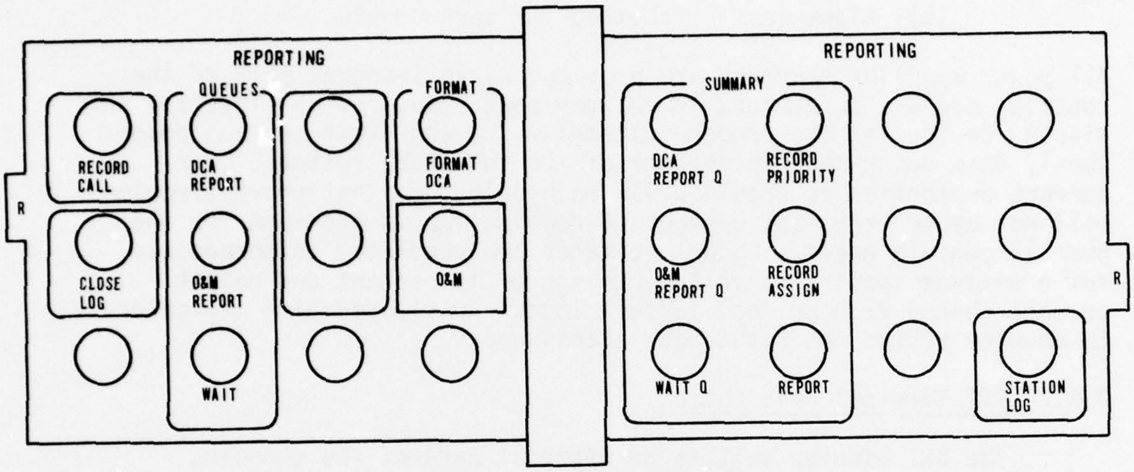


FIGURE 3-9. REPORTING PAGE PANEL

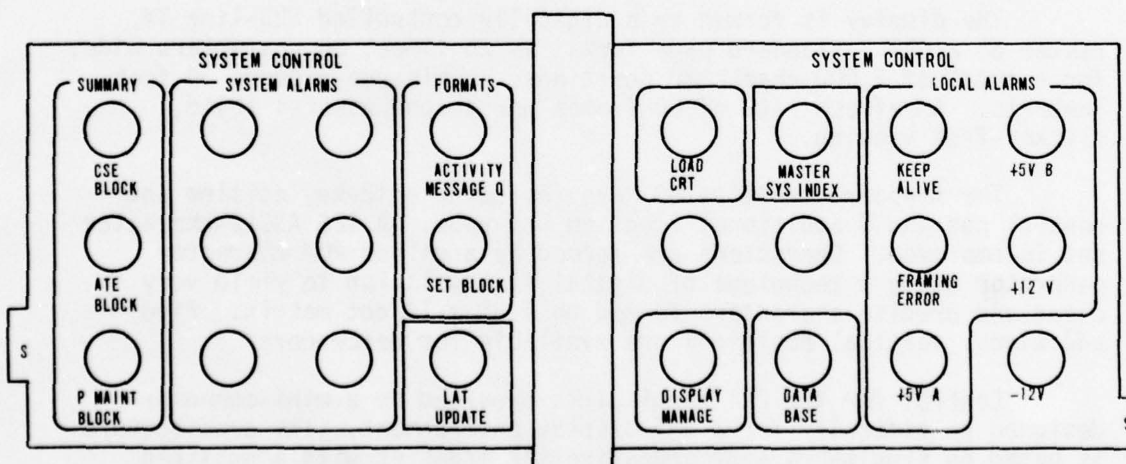


FIGURE 3-10. SYSTEM CONTROL PAGE PANEL

(3) Selector switch for panel meter voltages.

(4) Test points for each of the dc voltages (+5, +12, and -12V).

(5) Alarm test pushbutton for each supply.

All power supplies required are provided as an integral part of the console, and are sufficient to deliver power required by circuitry and display devices at the proper voltages. Current drain on each power supply does not exceed 75 percent of its full-load rating. Overcurrent protection is provided for each output so that short circuits will not cause permanent damage. A cooling fan is provided for the overall console needs. Output voltages are regulated to compensate for a maximum input line voltage change of 10 percent and output current change from no load to full load. An elapsed time indicator is mounted behind the right rear access door.

3.6.2 CRT Terminal Description.

The CRT Display unit is an integral part of the console, providing an alphanumeric display of output from the Central Processor Set as well as data entered by the operator from the keyboard. The CRT Display, with associated keyboard entry and edit capability, permits the call-up from the Central Processor Set report displays or data entry formats. These may be edited for correctness or additional commentary entered as necessary before returning the message to the CPS for storage or further handling. The CRT Display also allows the call-up of all status information available about in-station and out-of-station components of the network.

The display is formed by a digitally controlled 525-line TV raster on a CRT. Standard page format is 25 lines, 80 characters wide, for a total of 2,000 character positions. Luminance exceeds 30 foot-lamberts. A refresh rate of 60 frames per second assures solid, flicker-free viewing.

The keyboard contains 80 keys including a 12-key editing and control pad and 8 additional function key pads. A 128 ASCII character set is employed. Characters are formed by a unique ROM character generator using a technique of digital interpolation to yield very clear and precise characters formed on a 20 x 14 dot matrix. Five additional vertical positions are available for descenders.

Control for the CRT terminal is provided by a mini-computer designed specifically for a CRT display environment. Its architecture is based on single-bus source/destination transfer with a multiple field, micro-coded instruction format. The data format for bus transfer and display refresh is 10 bit parallel. The display buffer is random addressable, employing MOS-circuitry and contains 2,048 words.

Program instruction words are 16 bit parallel. They are contained in read-only or read-write storage. Although programs are possible requiring less than 1,000 instructions, up to 8,192 words may be stored in the processor. Programmable memory (PROMS) is used for read-only program memory. Random access MOS circuitry is used for read-write memory. The CRT Terminal contains a 2,048 word, 10-bit, random access memory for refreshing the screen. Two thousand characters of the memory are used for the refresh; forty-eight are available for buffering of I/O devices or for use as temporary storage. The screen refresh memory operates automatically, and requires no processor intervention. Seven of the memory's ten bits are normally used for storage of the ASCII code representing the character to be displayed on the screen. The other three bits are used as attribute bits for such functions as the control of protected data, intensification, underlining, blinking, tabbing, etc. Use of these attribute bits stored within the character eliminates the need for a separate storage location for attribute information. Up to 16,000 bytes are available for program or data storage in read-write memory. This memory is used for normal program storage and for storage of data for such needs as I/O buffering.

A data entry keyboard is provided and arranged in conventional typewriter style and includes all alphabet letters, all decimal digits, and the normal punctuation symbols. An auxiliary set of 20 special-function keys is provided for operator control of CRT Display, editing and output operation. The CRT and data entry keyboards are modular and interchangeable with other CPMAS consoles (when implemented). An editing cursor indicates the location on the CRT Display where the next character will be typed, erased or moved. The cursor is movable over the page using keys for lateral and vertical, single or multiple space motions. The cursor is controlled from both the main keyboard special-function array and the Central Processor Set.

SECTION 4

ATEC TERMINAL ELEMENT DESCRIPTIONS

4.1 GENERAL

This section contains detailed descriptions of the following ATEC Terminal Elements (ATEs), the subsystems of the CPMAS which perform the actual monitoring and interactive tests with the communications system:

Programmable ATEC Terminal Element (PATE)

Baseband Signal Analyzer (BBSA)

Alarm Reporting Subsystem (ARS)

Measurement Acquisition Unit (MAU) & MAU Options

4.2 PROGRAMMABLE ATEC TERMINAL ELEMENT (PATE)

The PATE, Figure 4-1, is a computer controlled test set capable of providing continuous automatic performance monitoring and assessment of communication circuits. The PATE, depending upon the option configuration, provides non-interfering, in-service monitoring and assessment of voice frequency (VF) circuits, frequency shift keyed (FSK) data subchannels contained in a composite frequency division multiplexed voice frequency circuit, and digital data circuits. The PATE also has the capability to provide automatic out-of-service tests of VF circuits by removal of the circuit from service at a bridge/break point. Out-of-service tests require patching of the circuit to be tested to station ATEC Jacks which connect with an A/C (bridge/break) Scanner. The PATE configurations determine combinations of test and analysis functions to be performed. Conversion from one configuration to another is accomplished by equipping the PATE with appropriate signal processing plug-in cards, the Test Signal Source (TSS), and scanners.

A block diagram of the PATE is shown in Figure 4-2. The PATE can be operated from a local I/O terminal in a stand-alone mode or remotely by the CPMAS Nucleus Subsystem. The choice of local or remote control is selected at the PATE location. Local input/output (I/O) control is performed by a Technical Controller using any compatible keyboard terminal which generates seven level ASCII code at 150 baud. Processing of monitored signals is accomplished by a Honeywell H-316R general purpose computer interfaced with a cartridge type Disk Drive Unit (DDU) which is used to provide mass storage and data handling capacity.

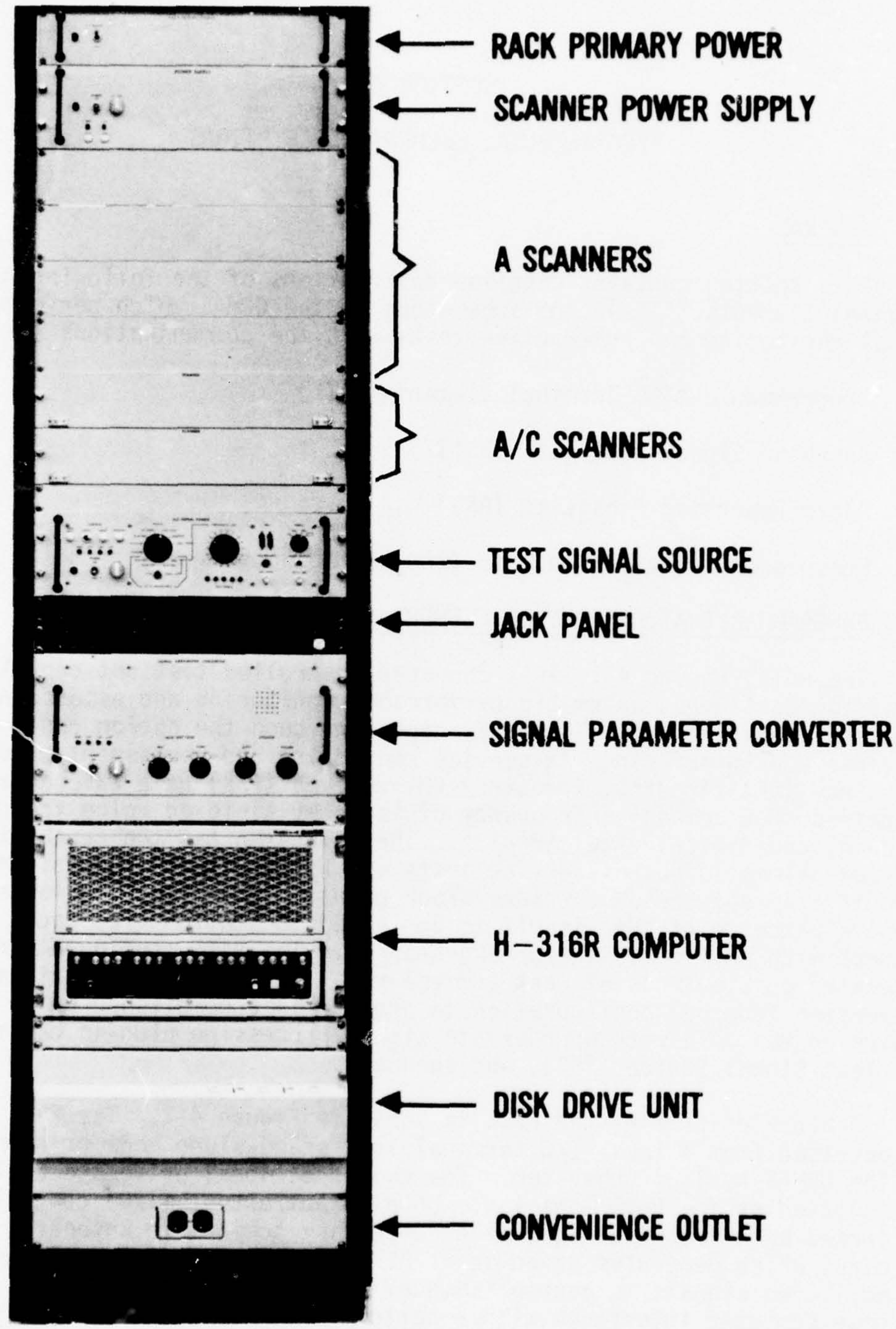


FIGURE 4-1. PROGRAMMABLE ATEC TERMINAL ELEMENT (PATE)

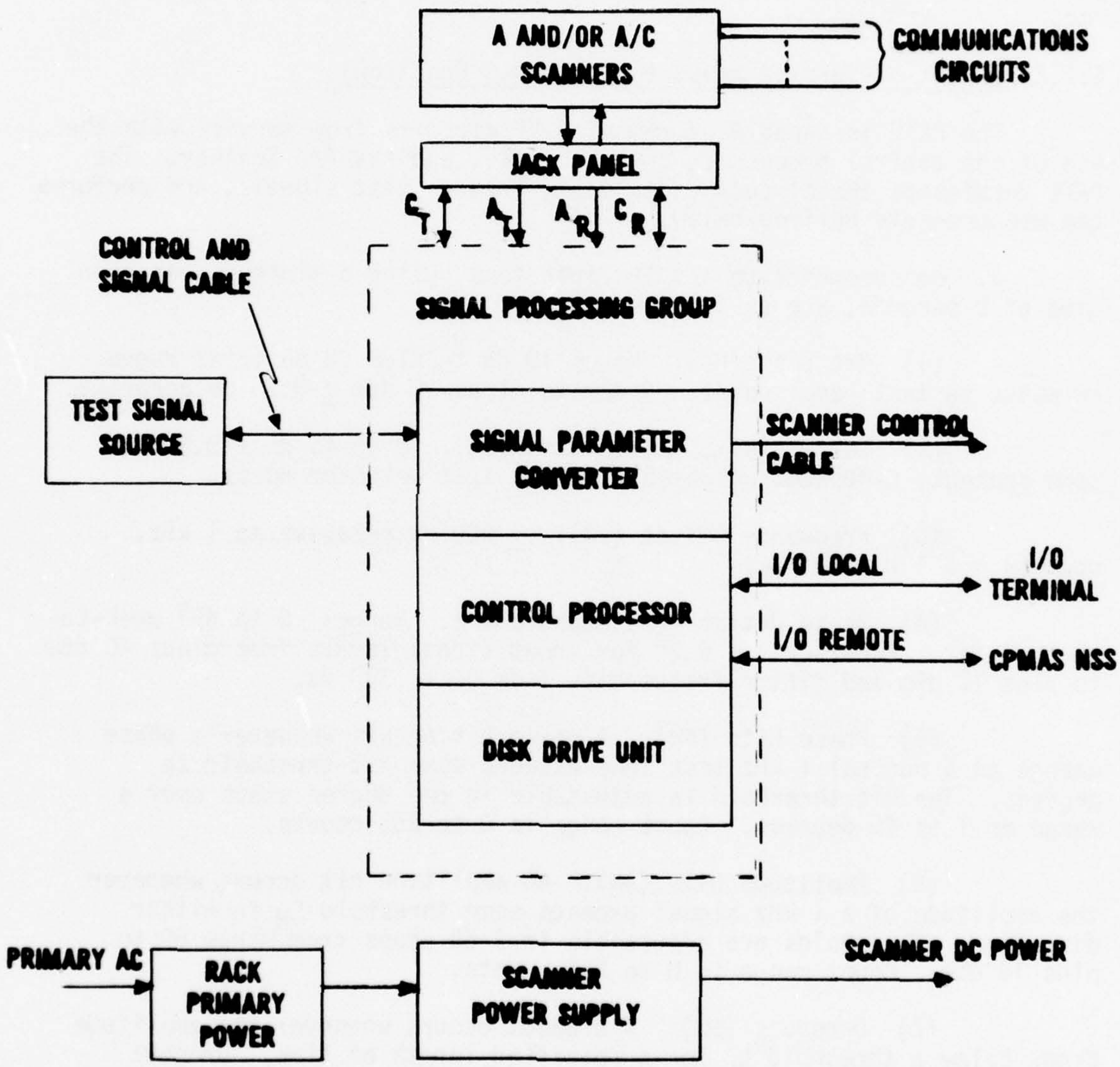


FIGURE 4-2. PATE BLOCK DIAGRAM

4.2.1 VF In-Service Measurements (IQCS Function).

The PATE is designed to monitor and assess the quality of VF circuits by sampling and digitizing the voltage amplitude of the monitored analog signal to calculate the parameters listed in Table 4-1. The PATE also uses these parameters to derive fourteen additional parameters of interest, e.g., Peak to Average Power (PA = PI minus AV), etc.

4.2.2 VF Out-of-Service Measurements (OQCS Function).

The PATE is capable of removing VF circuits from service with the use of the control processor, control logic, and the A/C Scanner. The PATE terminates the circuit under test, inserts test signals, and performs the measurements defined below.

a. Measurements on a 1 kHz test tone, using a minimum averaging time of 2 seconds, are as follows:

(1) Net Loss (NL): Minus 10 dB to plus 60 dB total range, relative to test level point. 0 dBm to minus 30 dBm ± 0.25 dB accuracy.

(2) Test Tone to Noise Ratio (SN): 0 to 45 dB ± 0.5 dB, tone present, C-Message weighted or 3 kHz flat weighted noise.

(3) Frequency Offset (FO): ± 500 Hz relative to 1 kHz, nominal ± 0.1 Hz accuracy.

(4) Phase Jitter (PJ) Measurement. Range: 0 to 45° peak-to-peak jitter. Accuracy: ± 0.2° for input signal levels from minus 40 dBm to plus 10 dBm and jitter frequencies from 20 to 300 Hz.

(5) Phase Hits (PH). A phase hit occurs whenever a phase change on a nominal 1 kHz test tone exceeds some hit threshold in degrees. The hit threshold is adjustable in one degree steps over a range of 1 to 45 degrees. Count range is 0 to 255 counts.

(6) Amplitude Hits (AH). An amplitude hit occurs whenever the amplitude of a 1 kHz signal exceeds some threshold L_H in either direction. Thresholds are adjustable in 1 dB steps from minus 60 to plus 10 dBm. Count range is 0 to 255 counts.

(7) Dropouts (DO). A dropout occurs whenever the amplitude drops below a threshold L_L for a specified length of time. Dropout threshold is adjustable in 1 dB steps from minus 60 to plus 10 dBm. Count range is 1 to 255 counts. Duration is programmable from 10 to 300 milliseconds in 2 millisecond steps.

TABLE 4-1. PATE VF IN-SERVICE MEASUREMENTS

Parameter	Symbol	Unit	Accuracy
Average Power (1)	AV	dBm	± 0.1 dB
Peak Instantaneous Power (1)	PI	dBm	± 0.1 dB
Minimum 10 ms Average Power (1)	I1	dBm	± 0.2 dB
Maximum 10 ms Average Power (1)	X1	dBm	± 0.2 dB
Minimum 50 ms Average Power (1)	I5	dBm	± 0.1 dB
Maximum 50 ms Average Power (1)	X5	dBm	± 0.1 dB
Volume Units (1)	VU	dBm	± 0.1 dB
Spectrum Filter Value where i = 100 to 4000 Hz (1)	SF_i	dBm	± 0.1 dB
Frequency (2)	FR	Hz	± 0.1 Hz
C-Message Weighted Noise (3, 5)	CN	dBm	± 0.2 dB
Unweighted Noise (3, 6)	FN	dBm	± 0.2 dB
3 kHz Flat Weighted Noise (3, 4)	WF	dBm	± 0.2 dB
Noise Coloration (3)	NC	dB	± 1 dB
Noise Frequency (3)	NF	Hz	± 50 Hz
Signal-Plus-Noise to Noise Ratio (1)	SN	dB	± 0.2 dB
Harmonic Distortion (1)	HD	dB	± 0.1 dB

Notes:

1. Specified accuracy is listed. Actual tested accuracy for particular signal level and frequency ranges are indicated in Figure 4-3.
2. Formal test results met specification accuracy requirements with the following exceptions: ± 1 Hz accuracy at - 80 dBm, ≥ 1000 Hz and ± 1 Hz accuracy at -50 dBm, 300 Hz.
3. Calculations dependent upon traffic type.
4. 3 kHz flat weighting characteristic as specified in Bell System Technical Reference PUB 41009.
5. C-Message weighting characteristic as specified in Bell System Technical Reference PUB 41009.
6. Unweighted. 100 to 4000 Hz spectrum values unweighted.

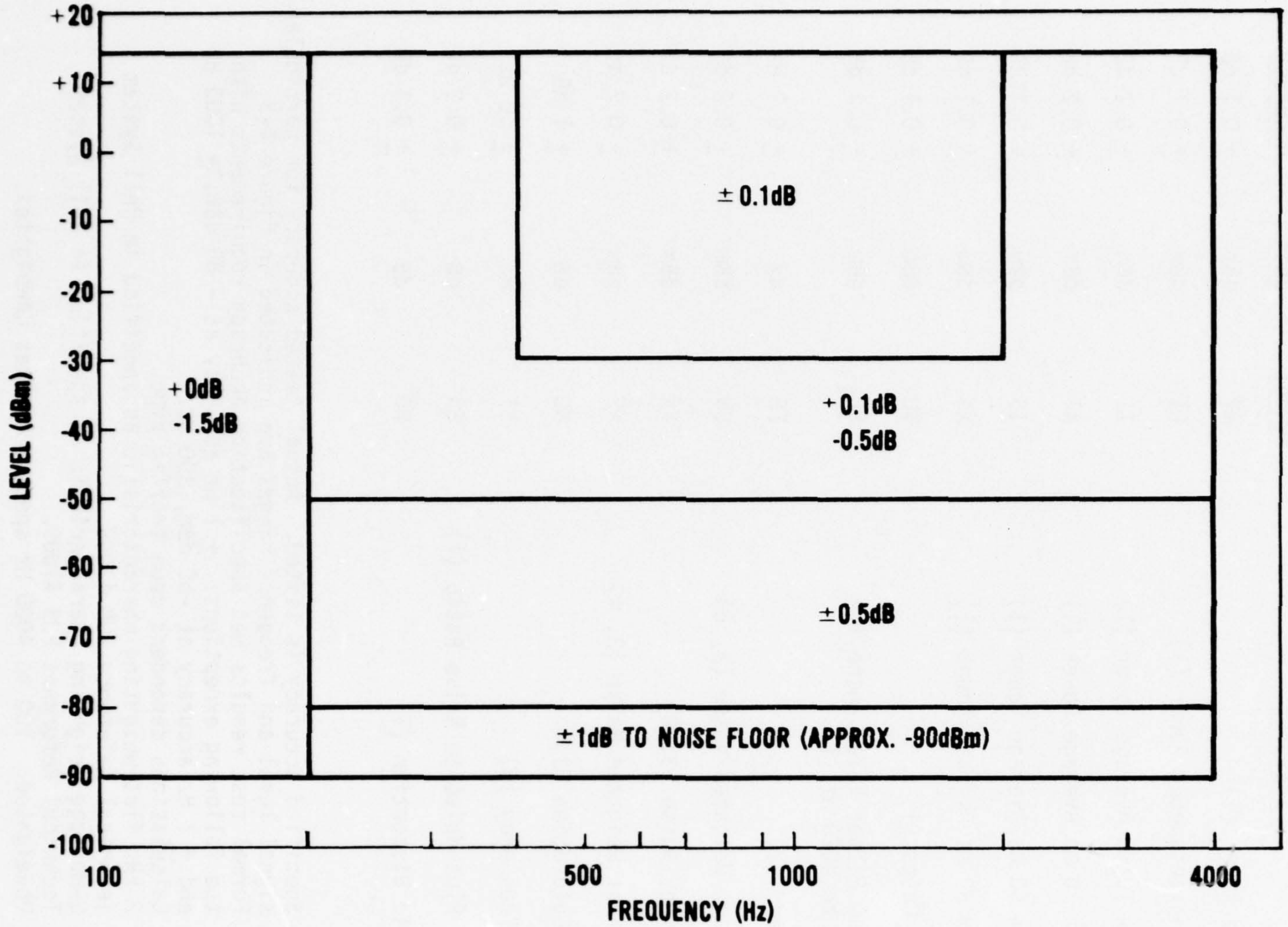


FIGURE 4-3. DEMONSTRATED PATE MEASUREMENT ACCURACIES

(8) Harmonic Distortion (HD). This is a measure of the relative magnitude of the fundamental frequency and the second and third harmonics. Accuracy is $\pm$ 1.0 dB for harmonics greater than minus 70 dBm and between 0 and minus 50 dB relative to the fundamental.

b. Measurements on a test signal consisting of a sine wave, frequency stepped in 100 Hz increments from 200 Hz to 3600 Hz with 50 percent, 25 Hz amplitude modulation (AM) are as follows:

(1) Measurement duration: 15 seconds for entire band, 200 Hz to 3600 Hz.

(2) Amplitude response (loss): minus 10 dB to plus 60 dB over stepped frequency range. 0 dBm to minus 30 dBm $\pm$ 0.25 dB accuracy over stepped frequency range.

(3) Envelope Delay (ED) response: $\pm$ 20 millisecond range between adjacent 100 Hz center frequencies. $\pm$ 20 millisecond range from 200 Hz to 3600 Hz. $\pm$ 20 microsecond (μs) accuracy over frequency over frequency range 600 Hz to 2700 Hz. $\pm$ 40 μs accuracy over frequency ranges 200 Hz to 600 Hz and 2700 Hz to 3600 Hz.

c. Intermodulation Distortion (IM) Measurements are made on a two-tone signal (tones at 700 Hz and 1100 Hz). Intermodulation distortion products are measured with $\pm$ 1 dB accuracy if they are above minus 45 dBm and greater than minus 40 dB relative to the average power of the 700 Hz and 1100 Hz tones. The intermodulation products of interest fall at the following frequencies.

$f_1 + f_2$ = 1800 Hz, second order

$2f_1 + f_2$ = 2500 Hz, third order

$-f_1 + 3f_2$ = 2600 Hz, fourth order

d. Measurements made on an idle channel with no intentional signals present other than possible interference are as follows:

(1) Averaging time: 2 seconds, nominal

(2) Spectrum measurement: Level range: minus 60 dBm to plus 10 dBm; Frequency range: 100 Hz to 4000 Hz; Frequency increments: 100 Hz.

(3) Spectrum measurement bandwidth per 100 Hz increment: 150 Hz nominal.

(4) Spectrum measurement accuracy per frequency increment: ± 0.1 dB from 100 to 4000 Hz provided that no band is 10 dB higher than another.

(5) Spectrum processing: Tone interference (or signal) is noted if a frequency increment level is greater by 6 dB than adjacent increments. The noise frequency is noted together with the level in dBm. C-Message noise (CN), 3 kHz flat (WF), and 3 kHz flat minus C-Message noise is measured to ± 0.5 dB accuracy.

(6) Impulse Noise (IN) measurement: Impulse noise measurement is operator selectable. The PATE detects and counts all events which occur during the test period above the three thresholds of L_1, L_2, L_3 dBm as preset.

4.2.3 Frequency Shift Keying (FSK) Measurements (MSMS Function).

The PATE is capable of extracting any subchannel from a group of 18 or fewer channels in a FSK data group. The PATE performs demodulation of binary FSK signals operating at maximum rates of either 75 baud (for 170 Hz spacing) or 150 baud (for 425 Hz spacing). The PATE performs the following measurements:

a. Normalized subchannel relative level (LS) with a ± 1 dB accuracy.

b. Mark/space envelope power level differential (ED) of a subchannel with a ± 1 dB accuracy.

c. Mark frequency error (EM) and space frequency error (ES) for a subchannel with a ± 1 Hz accuracy.

d. RMS deviation of the actual marking frequency (FM) relative to the specified marking frequency with a ± 1 Hz accuracy.

e. RMS deviation of the actual spacing frequency (FS) relative to the specified spacing frequency for a subchannel with a ± 1 Hz accuracy.

f. Peak distortion (PD) in percent for assigned synchronous or asynchronous subchannels with a ± 1 percent accuracy.

g. Bias distortion (BD) in percent for assigned synchronous or asynchronous subchannels with a ± 1 percent accuracy.

4.2.4 Digital Measurements (DDMS Function).

The PATE scans and analyzes digital data at rates of 9.6 kilobits (or less) per second (kBPS) with the use of the control processor, the control logic and an A Scanner. The PATE measures the duration of the mark waveforms and the space waveforms of digital data and performs the following measurements:

a. Baud error (BE) in percent, ± 1 percent.

b. Start bit error (SE) in percent, ± 1 percent.

c. Bias distortion (BD) in percent, ± 1 percent.

d. Fortuitous distortion (FD) in percent, ± 1 percent.

e. Peak distortion (PD) in percent, ± 1 percent.

f. Average operating margin (AM) in percent, ± 1 percent.

g. Minimum operating margin (MM) in percent, ± 1 percent.

4.2.5 Parameter/Threshold Comparison.

The PATE provides a comparison of parameter measurements to known/predetermined thresholds (as part of the PATE data base) and provides alarm conditions (hard copy) based on this comparison. The alarm conditions are "green", "amber", and "red". The range of each performance category is arbitrarily variable by the operator through the local or remote PATE input/output terminal.

4.2.6 Parameter Trending.

The PATE can provide temporal and diurnal trend status information to indicate parameter value movement as a function of time, excepting VF out-of-service measurements.

4.2.7 PATE Major Components.

The PATE (Figure 4-1) consists of a standard 19-inch electronic equipment rack which contains a Rack Primary Power Panel, a Scanner Power Supply, from one to six Scanners, a Test Signal Source, a Jack Panel, a Signal Parameter Converter, an H-316R Computer, and a Disk Drive Unit. These units are described in the following paragraphs. Also reference Figure 4-2, PATE Block Diagram.

a. Rack Primary Power Panel. The Primary Power Panel (Figure 4-4) contains a pilot lamp, a set of AC line filters, and an alternating current (AC) circuit breaker which functions as the rack ON-OFF switch. The panel provides AC power distribution to PATE components by means of a terminal strip to which all other rack units connect.

FIGURE 4-4. RACK PRIMARY POWER PANEL

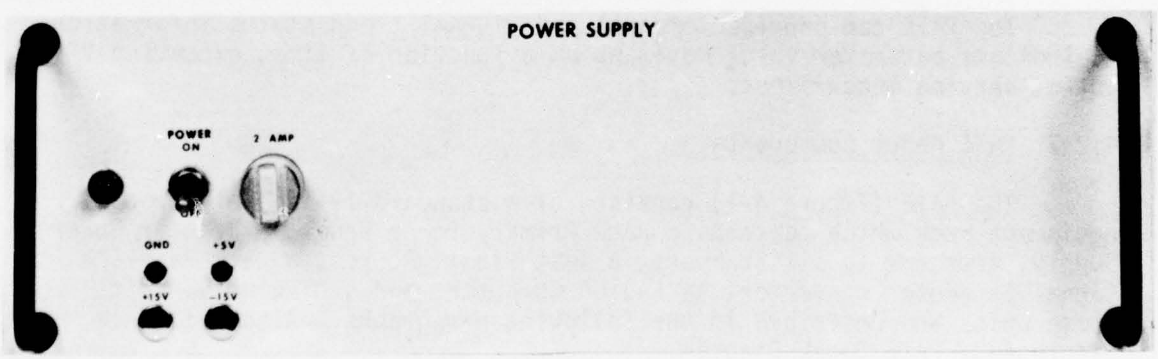


FIGURE 4-5. SCANNER POWER SUPPLY PANEL

b. Scanner Power Supply. The Scanner Power Supply (Figure 4-5) contains a regulated +5 Vdc power supply rated at 16 Amperes which provides operating power for up to six Scanner drawers through individual power cables. A POWER ON switch, 2-ampere fuse, and pilot light are mounted on the front panel. The pilot light indicates both the power ON condition and that the +5 Vdc output is available.

c. Scanners. The A and A/C Scanners shown in Figures 4-6 and 4-7 provide the interface between the communications circuits and the Signal Parameter Converter (SPC). The A and.A/C Scanner drawers both contain one circuit control card, one address decode card, and 10 relay cards. A slot is provided for a scanner test card, one of which is provided with each PATE.

The A Scanner contains Form A (bridge-on) relays and the A/C Scanner contains Form A relays and Form C (break) relays in combination. As shown in Figure 4-8, the Form A relay is a 3-pole, single throw relay and the Form C relay is a 3-pole, double throw relay. Each circuit consists of a three wire transmit line and a three wire receive line. One wire of a three wire configuration is shown in Figure 4-8. Two Form C relays and two Form A relays are required per circuit to provide the transmit and receive functions. The signal is always connected to the Form A relay first and then the Form C relay. The Form C relay interrupts the line while the Form A relay does not. A circuit consists of both the transmit line and the receive line. One or more of the relays for a circuit may be selected.

Each of the 10 A Scanner relay cards have 11 relays. Ten relays are used to selectively switch circuits to the SPC. The remaining relay functions as a fail-safe electronic switch to protect the data bus in the event of a relay failure. Collectively, the 10 circuit select relays provide the capability of scanning 100 two-wire Communication Circuit (half duplex) lines which are connected from the Intermediate Distribution Frame (IDF) to the two scanner Christmas tree terminal blocks. Monitoring is performed in a non-interfering manner, using a high impedance bridge-on connection. Circuit monitoring points are selected by these digitally controlled scanners as commanded by the Control Processor.

As Figure 4-7 indicates, the A/C Scanner contains four Form A type relay cards and six Form C type relay cards. The Form C cards differ from the Form A in that they have six relays: five Form C relays for half duplex Communication Circuit switching and one Form A to provide the fail-safe function. Due to the method of Form A and Form C card interconnection, the A/C Scanner capability is 30 two-wire circuits (15 full duplex circuits). A/C Scanner connections to monitored channels provide both bridge-on and break-in capabilities as required. This allows the OQCS portion of the PATE to monitor signals

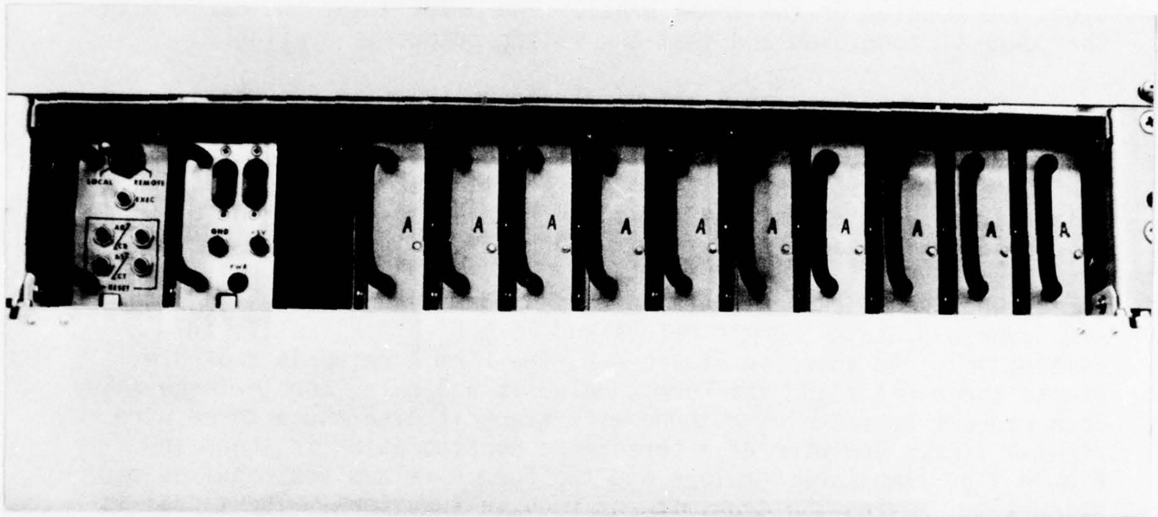


FIGURE 4-6. A SCANNER

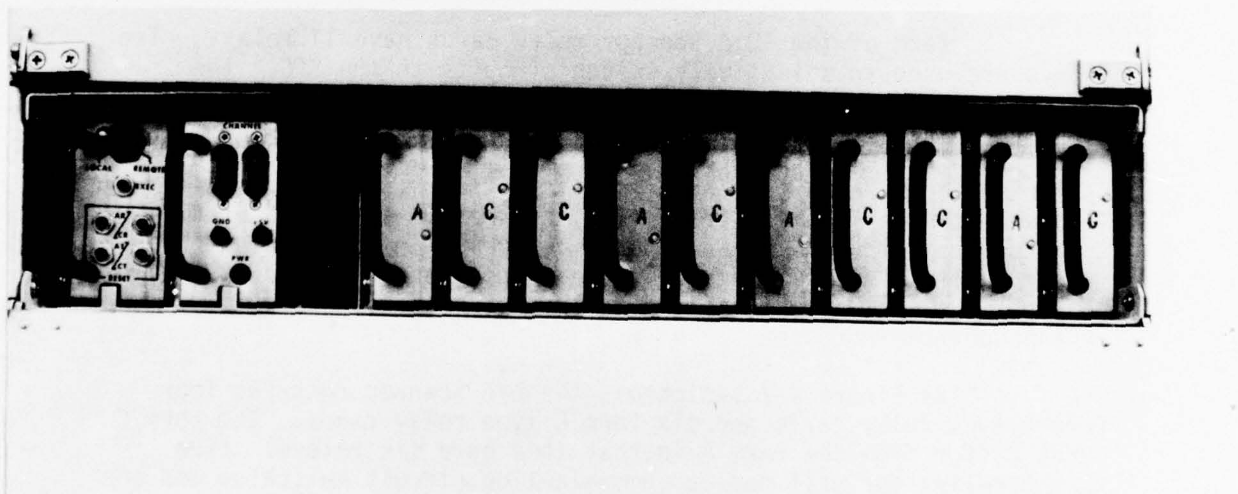
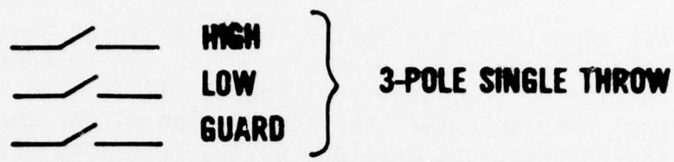
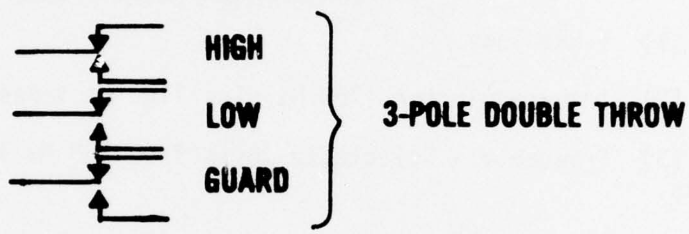


FIGURE 4-7. A/C SCANNER

1. FORM A RELAY CONFIGURATION



2. FORM C RELAY CONFIGURATION



3. ONE OF THREE (HIGH, LOW, GUARD) PER CIRCUIT

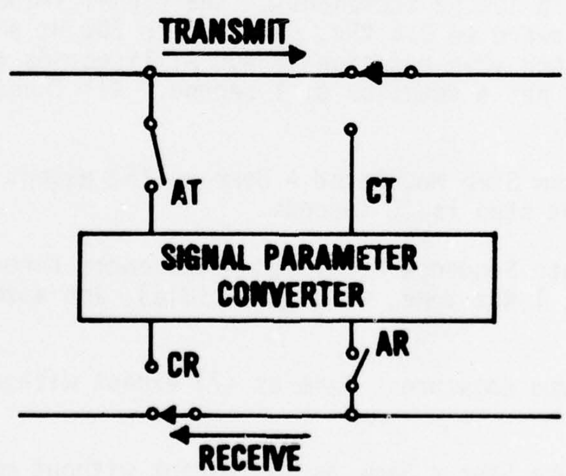


FIGURE 4-8. SCANNER RELAY CONFIGURATIONS

on a full duplex channel or break the circuit, terminate the receive side and inject signals from the Test Signal Source into the Transmit Side. Two of the Form A type relay cards are not used and provide bridge-on capability for monitoring an additional 10 circuits.

d. Test Signal Source (TSS). The Test Signal Source, Figure 4-9, is a multifunction signal generator which can be controlled by a remote ASCII device or from the front panel. It is used to inject a reference signal into an out-of-service VF channel for the purpose of determining its attenuation, envelope delay, intermodulation, and frequency response characteristics. The outputs available from the TSS are defined as follows:

(1) 1 kHz Tone.

(2) Intermodulation (700 Hz plus 1100 Hz tones).

(3) Frequency - Selectable tones from 200 Hz to 3600 Hz in 100 Hz steps.

(4) Frequency Modulated - Same as (3), but each tone selected is 50 percent modulated by 25 Hz.

(5) Auto Step Modulated - Output signal is stepped from 200 Hz to 3600 Hz in 100 Hz increments. The signal sequence begins at 2 kHz increments upward to 3.6 kHz, descends to 200 Hz and increments to 2 kHz again. Each step duration is 400 milliseconds except for the 2 kHz signal which has a duration of 1 second. All frequencies are modulated at 25 Hz.

(6) Slow Step Modulated - Same as (5) except each step is 8 seconds and 2 kHz step is 20 seconds.

(7) Auto Sequence Modulated - Sequences through two tone (Intermodulation), 1 kHz tone, no signal (idle), and auto step sequence (5).

(8) Auto Sequence - Same as (7) except without 25 Hz modulation.

(9) Auto Step - Same as (5) except without modulation.

(10) Slow Step - Same as (6) except unmodulated.

(11) No Signal - No output, line terminated in characteristic impedance.

Selectable output impedances of 135, 600, and 900 ohms are available. Provision has also been made for the incorporation of a special site peculiar impedance by hardware modification. The output signal levels

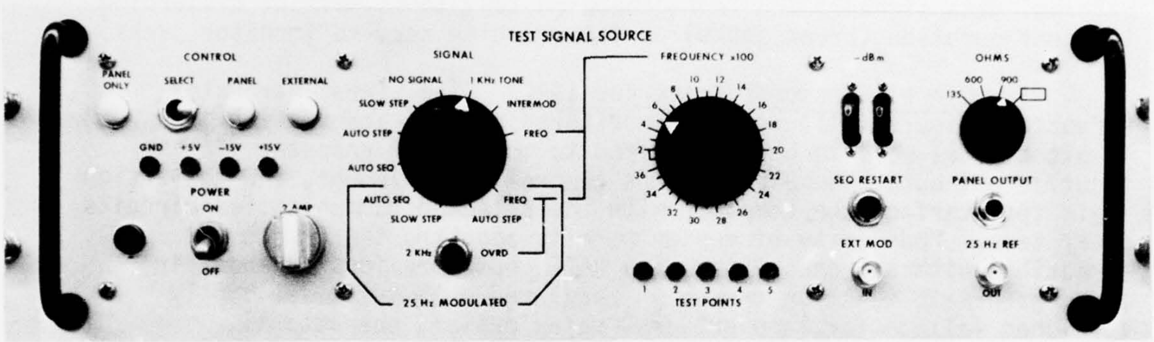


FIGURE 4-9. TEST SIGNAL SOURCE

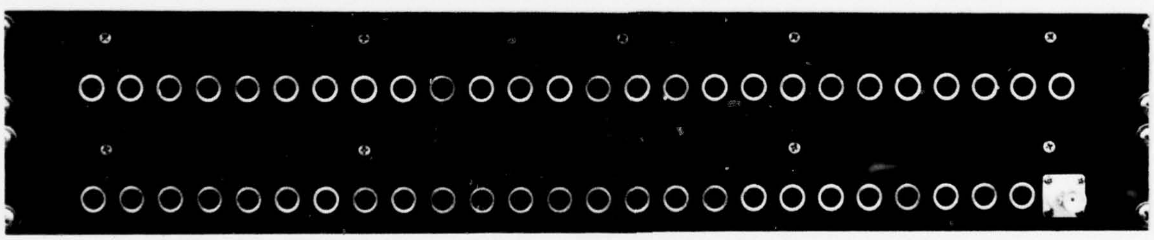


FIGURE 4-10. JACK PANEL

are selectable over a range of 0 dBm to -31 dBm (± 0.25 dB) in 1 dB steps. Single tone output second harmonic distortion is greater than 50 dB below the fundamental.

e. Jack Panel. The Jack Panel shown in Figure 4-10 contains two rows of jacks (26 in each row) that are horizontally oriented with the transmit functions on the top row and the receive functions on the bottom row. It is used to perform PATE maintenance functions and to manually access and monitor internal data signals and control lines, external data signals, and PATE-generated test tones without disturbing the configuration (break jacks) or interrupting service (monitor jacks).

f. Signal Parameter Converter (SPC). The Signal Parameter Converter (Figure 4-11) converts monitored channel information to a 16-bit digital word to be transferred to the H-316R computer via an input/output bus. The SPC contains control, measurement, and conversion logic to interface the computer with the selected communication circuits under test. Modularity of design permits adapting the SPC to be compatible with any one of the nine PATE configurations by inserting the appropriate function cards. A regulated ± 15 Vdc power supply furnishes voltage for lamp drivers, relay driver, operational amplifiers, and other control functions. A regulated +5 Vdc power supply furnishes logic level voltages. The power supplies are protected against overload and short circuits by current limiting circuits in the output stages and by an internal fuse against internal component failure.

The SPC drawer also contains input protection circuits to prevent damage from lightning surges, hits on the data lines or from incorrect signals applied through the Jack Panel. The input protection circuits consist of a fused line, plus a lightning arrestor.

For more detail on the operation of the SPC, refer to Paragraph 4.2.11 of this report.

g. H-316R Computer. The PATE operating program including the measurement parameters and operating thresholds, etc., are called up from the disk by the H-316R Computer as required to satisfy the functions commanded. Operating switches and displays are located on the computer front panel (Figure 4-12). A key lock switch prevents unauthorized operation or manipulation of the logic functions. The computer comes equipped with a 16K memory core stack, high speed arithmetic package, real time clock, auto restart, and base sector relocation capability. The computer input/output (I/O) operates at 150 baud. The I/O buffers are compatible with MIL-STD-188-100 low level, seven level ASCII code. The PATE program can be operated either automatically or as an interrupt program through use of a local input/output (I/O) terminal. Remote control of the PATE is accomplished through the Nucleus Subsystem. The choice of local or remote control is selected at the PATE position by the PATE Operator.

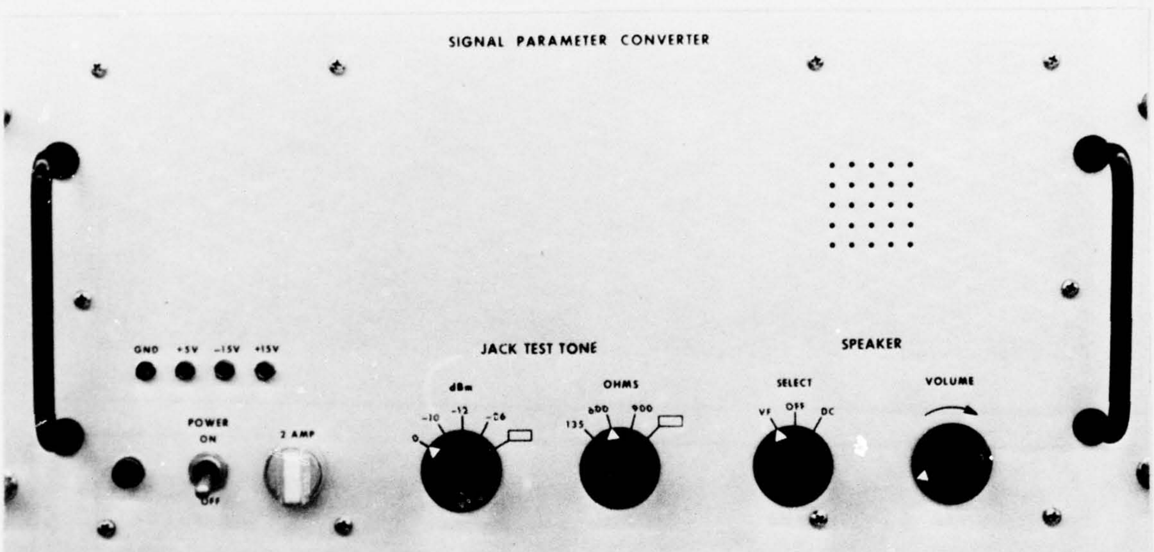


FIGURE 4-11. SIGNAL PARAMETER CONVERTER

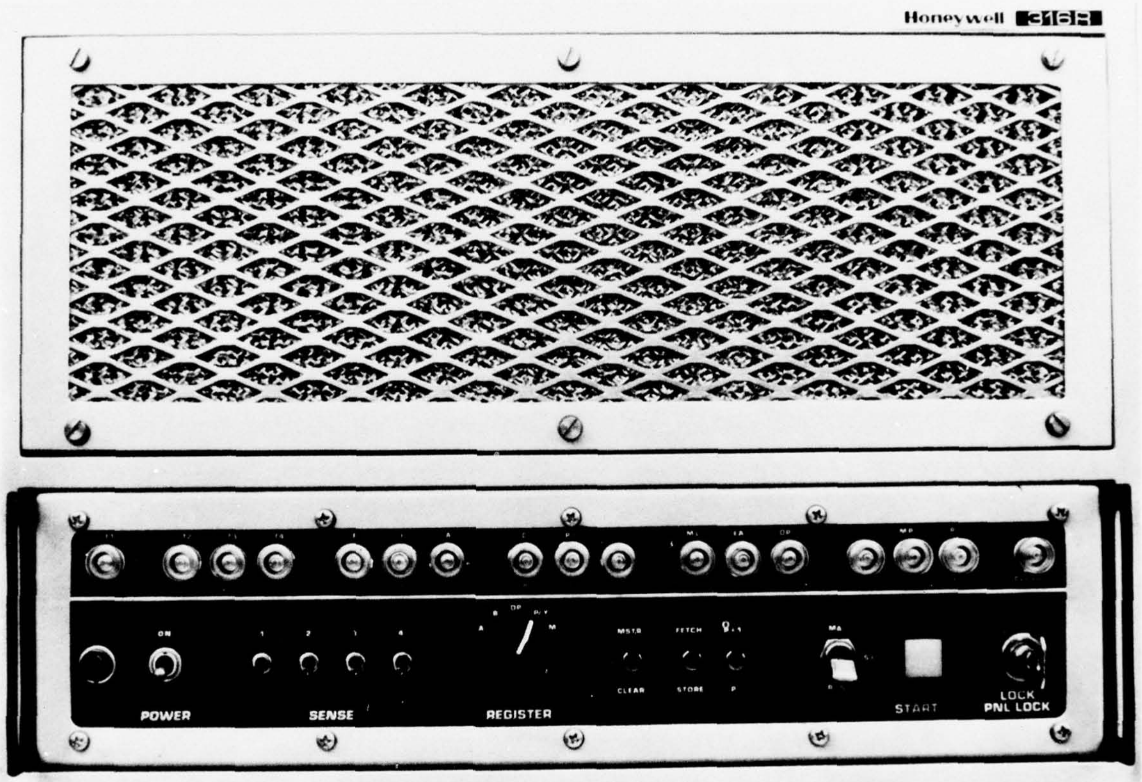


FIGURE 4-12. H-316R COMPUTER

h. Disk Drive Unit. The Disk Drive Unit (DDU) shown in Figure 4-13 is a dual, disk cartridge, servo controlled, drive unit and head positioner with one fixed and one removable cartridge. Each cartridge records at 220 bits per inch (BPI), and has a 48-megabit storage capacity. Each cartridge has two surfaces, providing a total of four surfaces for each disk unit. However, the cartridges are redundant. The DDU provides a total storage capacity of approximately 2.5 megawords of 16 bits each. The DDU is contained in its own enclosure and is suitable for installation in a standard 19-inch electronics equipment rack. A self-contained regulated power supply furnishes all required power supply voltages.

4.2.8 Input/Output (I/O) Terminal.

The I/O device currently used with the PATE is a pedestal configured General Electric Model 1200B TermiNet 1200B ASR (Automatic Send-Receive). The 1200B ASR consists of a KSR (Keyboard Sent and Receive) TermiNet 1200B Printer which is mounted on the International Pedestal as shown in Figure 4-14. A paper tape reader and punch is installed on the left side of the Pedestal.

a. Printer. The KSR version of the Printer has a keyboard similar to a standard office typewriter. The Printer can print and transmit information generated locally by the keyboard or another local device (e.g., paper tape reader). It can receive and print information from a remote terminal, computer, or other communication device. All of the 94 printable characters in the American Standard Code for Information Interchange (ASCII) can be printed. Printing speed is 15 characters per second.

b. International Pedestal. The International Pedestal provides a stable, compact support structure for the TermiNet 1200 Printer and accessories. The paper tape reader and punch (with power supply) are mounted on the left side of the Pedestal. The Photoelectric tape reader reads and sends 15 characters per second. The solenoid driver, paper tape punch operates at 10, 15, and 30 characters per second.

c. TermiNet 1200 Data. Physical, environmental, and electrical characteristics of the TermiNet Printer and International Pedestal are given in Table 4-2.

4.2.9 PATE Functional Configurations.

The PATE may be configured for any combination of nine measurement functions. The nine functional combinations with their commonly used abbreviations are listed in Table 4-3. PATE In-Service configurations can be reconfigured by adding or removing printed circuit cards, located in the Signal Parameter Converter drawer card nest. Circuit card configurations are shown in Table 4-4.

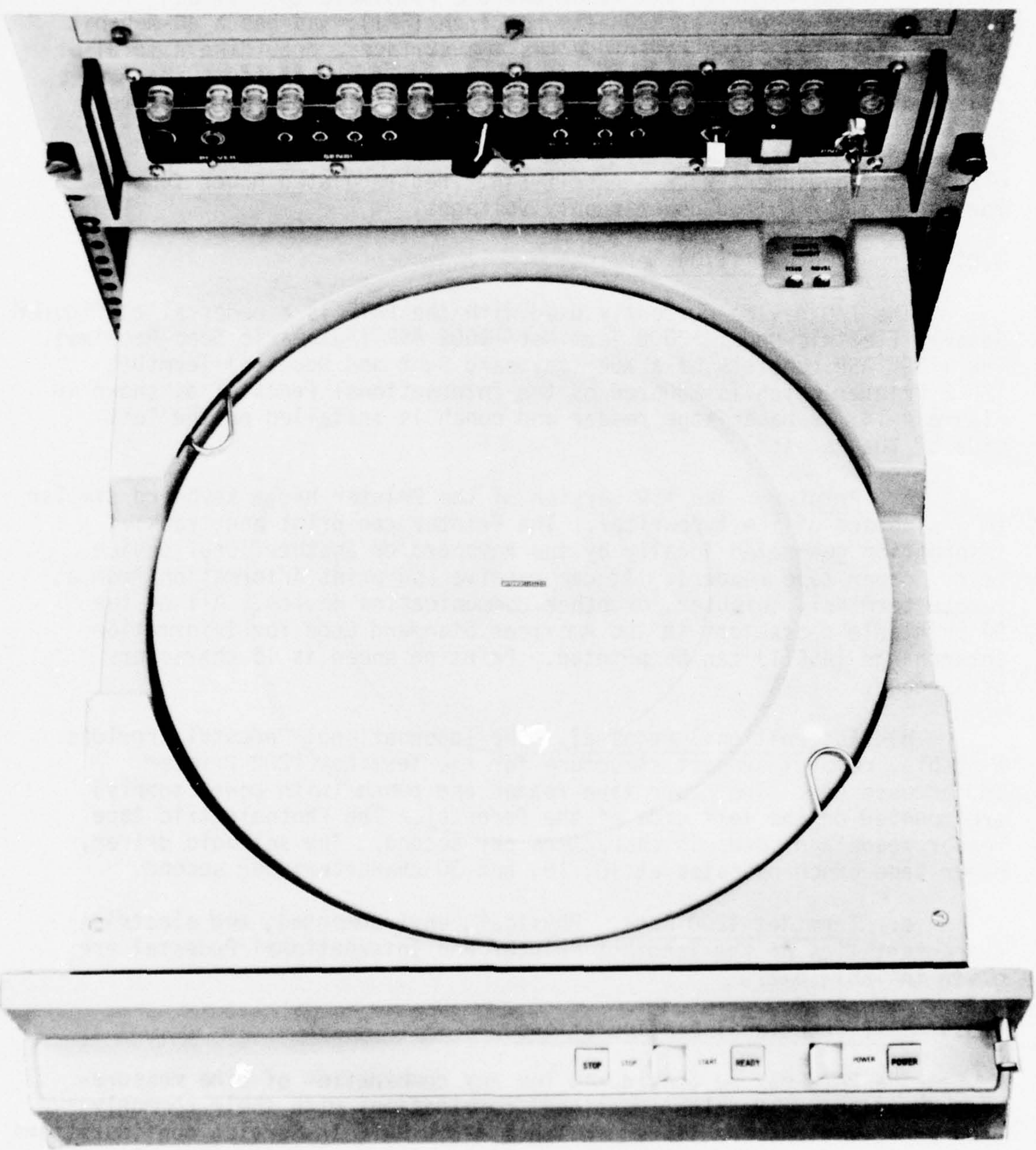


FIGURE 4-13. DISK DRIVE UNIT

FIGURE 4-14. TERMINET 1200B ASR

TABLE 4-2. TERMINET 1200B ASR DATA

TERMINET PRINTER

Physical Data

Height:	11 9/16 in. (33 cm)
Width:	20 1/2 in. (52 cm)
Depth:	31 3/4 in. (80 cm)
Weight:	90 lbs. (41 kg)

Environmental Data

Operating Temperature:	+32°F (0°C) to +110°F (44°C)
Storage Temperature:	-20°F (-28.9°C) to +160°F (71.0°C)
Relative Humidity:	10 to 95% Operating and Non-operating (No condensation)
Altitude:	0 to 12,000 Feet (3,650 Meters) Operating 0 to 50,000 Feet (15,240 Meters) Non-operating

Electrical Data

Input Power:	220 ± 10% VAC, Single Phase, 50 Hz (± 1 Hz)
Power Usage:	Standby - 60 Watts Motor On - 120 Watts Printing - 175 Watts

INTERNATIONAL PEDESTAL

Physical Data

Height:	25 7/8 in. (65.8 cm)
Width:	18 3/4 in. (47.6 cm)
Depth:	20 1/2 in. (52.1 cm)

TABLE 4-2. TERMINET 1200B ASR DATA (Continued)

Basic Weight:	32 lbs. (14.5 kg)
Tape Reader/Punch/ Power Supply Weight:	49 lbs. (22.2 kg)
Power Trans. Weight:	18 lbs. (8.2 kg)

Environmental Data

None. Locate to conform to Printer environmental requirements.

Electrical Data

50 Hz Power Transformer:	Converts 100/120/200/220/240 VAC to 120/220/240 VAC Conforms to International Electrotechnical Commission (IEC) specifications

TABLE 4-3. PATE CONFIGURATIONS

AN/GYM-12(V) Variable No.	Measurement Functions				Common Name
	VF In-Service	VF Out-of-Service	FSK In-Service	Digital In-Service	
1	X				IQCS
2	X	X			I/OQCS
3				X	DDMS
4	X		X		IQCS-MSMS
5	X	X	X		I/OQCS-MSMS
6	X		X	X	IQCS-MSMS-DDMS
7	X			X	IQCS-DDMS
8	X	X		X	I/OQCS-DDMS
9	X	X	X	X	I/OQCS-DDMS-MSMS

NOTE: IQCS - In-Service Quality Control Function
I/OQCS - In-Service/Out-of-Service Quality Control Function
DDMS - Digital Distortion Monitoring Function
MSMS - Modem Signal Monitoring Function

TABLE 4-4. SPC CARD NEST CONFIGURATIONS FOR PATE FUNCTIONS

Card Slot	Card Function	PATE Configuration									
		IQCS		DDMS		I/OQCS		IQCS DDMS		I/OQCS DDMS	
		-	M	-	-	-	M	-	M	-	M
A1	Frequency Generator and Control	X	X	X		X	X	X	X	X	X
A2											
A3	Scanner Interface Control	X	X	X		X	X	X	X	X	X
A4	MSMS Self-Test Generator	-	X	-		-	X	-		-	X
A5	Test Tone Transmitter Control	X	X	X		X	X	X	X	X	X
A6											
A7											
A8	MSMS Filters	-	X	-		-	X	-	X	-	X
A9											
A10	MSMS Converter Discriminator	-	X	-		-	X	-	X	-	X
A11											
A12	DC Input Interface	-	-	X		-	-	X	X	X	X
A13											
A14											
A15	Test Tone Transmitter Output	X	X	X		X	X	X	X	X	X
A16	Device Address Decoder	X	X	X		X	X	X	X	X	X
A17	Input/Output Buffer	X	X	X		X	X	X	X	X	X
A18	Period to Digital Converter No. 2	-	X	-		X	X	-	X	X	X
A19	Period to Digital Converter No. 1	-	X	X		X	X	X	X	X	X
A20	Impulse Counter Control	-	-	-		X	X	-		X	X
A21	Rectified Mean	-	-	-		X	X	-		X	X
A22	Analog/Digital Converter	X	X	-		X	X	X	X	X	X
A23											
A24	Envelope Detector and Delay Comp	-	X	-		X	X	-	X	X	X
A25											
A26	Voice Frequency Input Amp	X	X	-		X	X	X	X	X	X
A27											
A28	Scanner Interface	X	X	-		X	X	X	X	X	X
A29	Input Counter Input	-	-	-		X	X	-		X	X
A30											
	PATE Variable No.	1	4	3	-	2	5	7	6	8	9

NOTE: M - MSMS Function

Reconfiguration to add or remove Out-of-Service functions requires reconfiguration of the Scanners, rewiring of the Scanner terminal blocks and main frame cross-connects, and adding or removing the Test Signal Source. It should be noted that, after initial installation, changes in PATE configuration is required only if there are changes in the traffic type which is being monitored or changes in the requirements for Out-of-Service measurements.

4.2.10 PATE Software.

The software package controlling the PATE consists of three major parts: the operating system, application programs, and support software. The operating system provides control and execution of the application programs. The application programs contain IQCS, OQCS, DDMS, and MSMS modules, which perform the appropriate calculations and analyses required for each communication system performance assessment function. The support software provides program load, disk directory generation and programmer debug aid packages.

The PATE software modules are listed in Table 4-5. (For detailed information on the contents of the modules, refer to the Computer Program Product Specification for Test Set, Electronics System AN/GYM-13(V), CP75000872.)

4.2.11 PATE Operation.

Assume the PATE is in its maximum capability configuration (Figure 4-15) and is under computer control at the beginning of a scan cycle. The computer commands a relay in the scanner, which corresponds to the address of the first monitor point, to close and make a bridge-on connection with the traffic circuit. The monitored traffic signal is routed through the Jack Panel to the scanner interface circuit located in the Signal Parameter Converter. Dependent on traffic type (analog, digital, or FSK) as programmed for the monitor point, the incoming data is routed to the VF or dc front end circuit. Digital signals are routed from the dc front end to period-to-digital (P/D) converter No. 1 which converts digital mark space time interval to a binary number. The P/D No. 1 output is then outputted via the input/output (I/O) buffers to the H-316R where the binary formatted data is analyzed by the particular algorithms contained in the computer program for the traffic type being measured. Similarly, analog signals are routed to the analog-to-digital (A/D) converter. After conversion, the binary output is routed to the computer through the I/O buffers and is processed in the same manner as the digital signal. Frequency shift keyed (FSK) signals are amplified by the VF front end and then applied to the MSMS circuitry where individual subchannels are extracted. The extracted subchannel is sent to the envelope detector where it is converted to dc for level information. The signal is amplitude limited and sent to P/D No. 2 for frequency determination. The amplitude limited signal is also applied to a phase-locked-discriminator for demodulation of the FSK signal into a digital signal. The recovered digital signal is applied to P/D No. 1 where the mark and space time periods are converted to a binary number.

TABLE 4-5. SOFTWARE REQUIREMENTS FOR PATE FUNCTIONS

Software Modules/Function	PATE Variable No.								
	1	2	3	4	5	6	7	8	9
ATEC Disk Operating System	X	X	X	X	X	X	X	X	X
IQCS Measurement	X	X		X	X	X	X	X	X
DDMS Measurement			X			X	X	X	X
MSMS Measurement				X	X	X			X
OQCS Measurement		X			X			X	X
Trend Analysis	X	X	X	X	X	X	X	X	X
IQCS Data Base Control	X	X		X	X		X	X	X
DDMS Data Base Control			X			X	X	X	X
MSMS Data Base Control				X	X	X			X
Common Operator Interaction	X	X	X	X	X	X	X	X	X
IQCS Operator Interaction	X	X		X	X		X	X	X
ANS Interaction	X	X	X	X	X	X	X	X	X
Summary Report Generation	X	X	X	X	X	X	X	X	X
Monitor Table Executor	X	X	X	X	X	X	X	X	X
End of Scan Scheduler	X	X	X	X	X	X	X	X	X
System Loader	X	X	X	X	X	X	X	X	X
Patch	X	X	X	X	X	X	X	X	X
Disk Utility	X	X	X	X	X	X	X	X	X
ANS IQCS Interaction	X	X		X	X		X	X	X
ANS DDMS Interaction			X			X	X	X	X
ANS MSMS Interaction				X	X	X			X
ANS OQCS Interaction		X			X			X	X
IQCS Self-Test	X	X		X	X		X	X	X
DDMS Self-Test			X			X	X	X	X
MSMS Self-Test				X	X	X			X
Alarm Verification	X	X	X	X	X	X	X	X	X
DDMS Operator Interaction			X			X	X	X	X
MSMS Operator Interaction				X	X	X			X
OQCS Operator Interaction		X			X			X	X
IQCS CCSD Sort	X	X		X	X		X	X	X
DDMS CCSD Sort			X			X	X	X	X
MSMS CCSD Sort				X	X	X			X

NOTE: ANS - ATEC Nucleus Subsystem
CCSD - Command Communications Service Designator

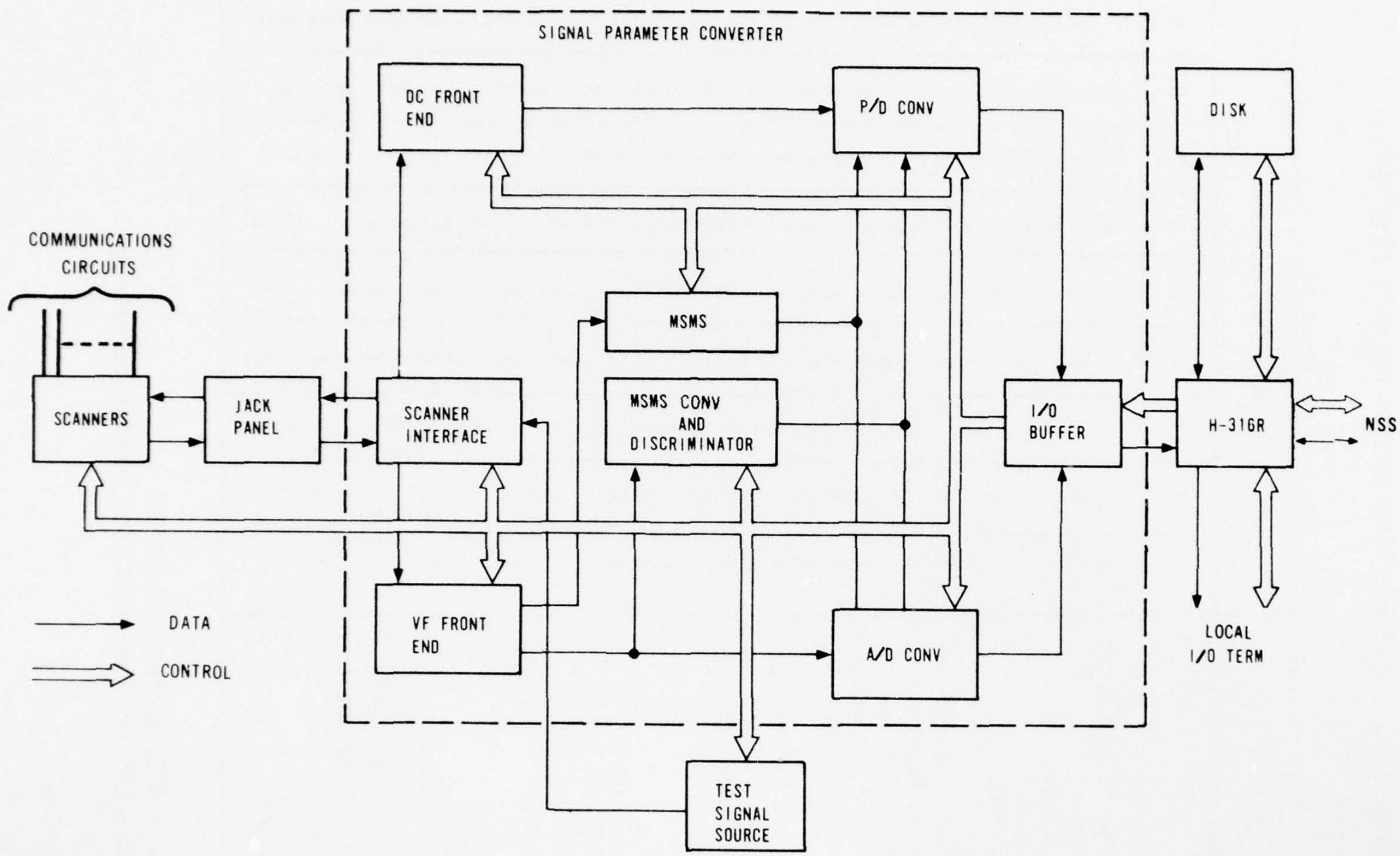


FIGURE 4-15. SIGNAL PARAMETER CONVERTER - BLOCK DIAGRAM

Upon completion of a measurement by the computer, the input to the PATE is stepped to the next monitor point in the scan sequence and the process of measurement and computation is repeated. Upon completion of all measurements in the scan sequence, the results are outputted to the I/O terminal.

Out-of-service measurements are not normally programmed to be done automatically since this could cause an interrupt to traffic transmission. Signal lines which are connected for out-of-service measurements are normally connected for in-service measurements also. When in-service measurements indicate a particular signal path is degrading in performance, the technical controller can use the I/O terminal keyboard to generate commands for continuous monitoring to obtain trend analysis or, upon coordination with the distant terminal, command an out-of-service measurement.

4.2.12 PATE Leading Particulars.

The leading particulars of the PATE are summarized in Table 4-6.

4.3 BASEBAND SIGNAL ANALYZER (BBSA)

The BBSA, Figure 4-16, is a computer controlled tunable signal measurement and translation device capable of monitoring baseband frequencies (12 kHz to 5 MHz) used in frequency division multiplex (FDM) communications systems. The BBSA, which contains a minicomputer to perform the internal control and analysis functions, performs primarily under control of the Nucleus Subsystem (NSS). The BBSA can also be operated locally in a fall-back or maintenance mode under control of an I/O terminal. Operating under control of the NSS or a local I/O terminal, it provides automated analysis of various elements of a selected FDM baseband and can also inject a test tone at any point in the baseband. In addition, the BBSA can extract channel bandwidth signals for additional analysis and also provides a spectrum display output for local use. The BBSA is capable of automatic scanning of eight full duplex baseband appearances, each appearance having 600 channels (or less). The primary functions performed by the BBSA are:

a. Non-interfering in-service VF channel measurements at group, supergroup, and baseband frequencies.

b. Insertion of single frequency test signals into an operating baseband. This capability can be used in conjunction with another BBSA (or with a PATE) at a distant site, to perform overall link assessment testing.

c. Translation of selected channels, from the baseband signal, to the voice frequency band for external analysis. By combining this function with a local PATE, an extremely versatile assessment tool is provided to the Nucleus Subsystem.

TABLE 4-6. PATE LEADING PARTICULARS

<u>Dimensions (inches)</u>	84.25H X 22.00W X 30.50D
<u>Weight</u>	768 pounds (See Note 1)
<u>Power</u>:	
Primary ac	115 vac ± 10 percent, 50 Hz ± 1 percent, or 60 Hz ± 1 percent, 3 wire, single phase
dc, self-contained Power Supplies	+5v ± 5 percent, regulated ± 15v ± 5 percent, regulated
Consumption	700 watts (See Note 1)

Note 1: Includes four A Scanners, two A/C Scanners, and a TSS.

<u>Cabling Requirements</u>	External cabling fabricated on site. Internal cabling furnished.

<u>In-Service Quality Control Function (IQCS)</u>

System Input:	
Frequency	100 Hz to 4.1 kHz
Range	+14 to -80 dBm
Maximum Input Amplitude	30 volts pk-pk
Input Impedances (ohms):	
Terminating (4)	135, 600, 900, one selectable
Bridging	>10K ohm dc, >10K ohm ac
Circuit Capacity	100 bridge only (50 full duplex) per scanner
Basic Measurement Accuracy:	
Average Power	+14 dBm to -80 dBm ± 0.1 dB
Peak Power	+14 dBm to -80 dBm ± 0.1 dB
Signal Spectral Composition	± 0.1 dB in 100 Hz increments from 100 to 4000 Hz

TABLE 4-6. PATE LEADING FARTICULARS (Continued)

Derived Measurement Accuracy:	
Noise (C-Message)	± 0.2 dB for noise > -70 dBm
Frequency	± 0.1 Hz from 250 to 3850 Hz
Harmonic Distortion	± 0.1 dB for harmonics between 0 and -50 dB relative to fundamental and > -70 dBm
Signal to Noise Ratio	± 0.2 dB when signal to noise is 20 dB or greater

Note 2: The IQCS accuracies cited above are specified. See Table 4-1, Notes 1 and 2, for exceptions.

<u>Out-of-Service Quality Control Function (OQCS)</u>

Circuit Capacity	15 full duplex and 10 bridge only per scanner
Measurements on a test tone transmission at 1 kHz:	
Averaging Time	2 seconds, minimum
Loss	-10 dB to +60 dB total range 0 dBm to -30 dBm ± 0.25 dB accuracy
Test Tone to Noise Ratio	0 to 45 dB ± 0.5 dB, tone present, C- Message weighted or 3 kHz flat weighted noise
Frequency Offset	+500 Hz relative to 1 kHz, nominal ± 0.1 Hz accuracy
Phase Jitter Measurement:	
Range	0 to 45 degree peak-to-peak jitter
Accuracy	± 0.2 degree for input signal levels from -40 dBm to +10 dBm and jitter frequencies from 20 to 300 Hz
Phase Hits	Threshold adjustable in 1 degree steps over a range of 1 degree to 45 degrees

TABLE 4-6. PATE LEADING PARTICULARS (Continued)

Amplitude Hits	Threshold adjustable in 1 dB steps from -60 to +10 dBm
Dropouts	Threshold adjustable in 1 dB steps from -60 to +10 dBm
Harmonic Distortion	$\pm$ 1.0 dB for harmonics greater than -70 dBm and between 0 and -50 dB relative to the fundamental
Measurements on a line having an input test signal of a 0 dBm sine wave, frequency stepped from 200 Hz to 3600 Hz amplitude modulated at 50 percent by 25 Hz:	
Step Increments	100 Hz
Measurement Duration	15 seconds for entire band, 200 Hz to 3600 Hz
Amplitude Response (Loss)	-10 dB to +60 dB over stepped frequency range
	0 dB to +30 dB $\pm$ 0.25 dB accuracy over stepped frequency range
Envelope Delay	$\pm$ 20 millisecond range between adjacent 100 Hz center frequencies
	$\pm$ 20 millisecond range from 200 Hz to 3600 Hz
	$\pm$ 20 microseconds (µs) accuracy over frequency range 600 Hz to 2700 Hz
	$\pm$ 40 µs accuracy over frequency ranges 200 Hz to 600 Hz and 2700 Hz to 3600 Hz
Intermodulation Distortion measurements made on a two-tone signal (700 Hz and 1100 Hz):	

TABLE 4-6. PATE LEADING PARTICULARS (Continued)

Intermod Distortion Products	
Accuracy	± 1 dB above -45 dBm and greater than -40 dB relative to the average power of the 700 Hz and 1100 Hz tones
Frequencies	$f_1 + f_2$ = 1800 Hz, 2nd order $2f_1 + f_2$ = 2500 Hz, 3rd order $-f_1 + 3f_2$ = 2600 Hz, 4th order
Measurements made on idle channel(s) with no intentional signals present:	
Averaging Time	2 seconds nominal
Spectrum Measurement:	
Level Range	-60 dBm to +10 dBm
Frequency Range	100 Hz to 4000 Hz
Frequency Increments	100 Hz
Spectrum measurement bandwidth per 100 Hz increment	150 Hz nominal
Spectrum Processing	Tone interference is noted if a frequency increment level is greater by 6 dB than adjacent increments
Impulse Noise Measurement	Detects and counts all events which occur during the test period above three preset thresholds, in dBm

Test Signal Source (TSS) (Part of OQCS Function)

Output Level	Selectable in 1 dB increments over a range of 0 dBm to -31 dBm (± 0.25 dB) rms signal power
Frequency Stability	± 0.05 Hz

TABLE 4-6. PATE LEADING PARTICULARS (Continued)

Signal/Noise Ratio	55 dB from 100 Hz to 4 kHz 40 dB (min) at 20 kHz
1 kHz Test Tone Mode	
Phase Jitter	$\leq$ 1.0 degree
Frequency Stepped AM Time Sequence Mode	
Envelope Phase Stability (operating time period of 300 seconds or less)	$\pm$ 10 microseconds over frequency range from 600 Hz to 2700 Hz $\pm$ 20 microseconds over frequency range from 200 Hz to 3600 Hz
Simultaneous Tone Mode Intermodulation Distortion Products	The two tone signal output (700 Hz plus 1100 Hz) intermodulation distortion products are at least 60 dB below rms signal level

<u>Digital Distortion Monitoring Function (DDMS)</u>

System Inputs:	
Frequency:	
Asynchronous	25-10,000 baud
Synchronous	50-10,000 baud
Amplitude:	
Maximum	$\pm$ 120V
Impedance:	
All Modes	$>$ 10K ohms
Measurement Accuracy:	
25-10,000 Baud	$\pm$ 1 percent

TABLE 4-6. PATE LEADING PARTICULARS (Continued)

Modem Signal Monitoring Function (MSMS)	
FSK Signal Range	425 Hz to 3485 Hz
Channel Groups	18 channels with bandwidth (BW) of 85 Hz
	12 channels; 8 channels having 85 Hz BW and 4 channels having 170 Hz BW
Power Utilized	± 15 vdc ± 10 percent
	+5 vdc ± 10 percent
H-316R Computer	
Input/Output	150-baud, low level ASCII code, 16-bit parallel
Memory Cycle Time	1.6 microseconds/4,096 words
Add Time	3.2 microseconds (maximum)
Instructions	72 instructions (minimum)
Input Power	115 vac ± 10 percent, 47.5 to 63.0 Hz
Disk Memory Unit (DDU)	
Data Storage:	
Fixed disk	24,000,000 bits
Removable disk	24,000,000 bits
Tracks/surface	204
Sectors/track	32 (maximum)
Bit density	2200 bits/inch, inside track (maximum)
Transfer Rate	2.5 MHz at 2400 rpm
Input Power	100 to 240 vac ± 10 percent, 50 or 60 Hz ± 1 percent

TABLE 4-6. PATE LEADING PARTICULARS (Continued)

Scanners	
Insertion Loss (Measured at 1 kHz, 600 ohms)	0.01 dB
Path Resistance	0.25 ohm
Line to Line Capacitance (Low side of line and shield common)	400 pf
Crosstalk Loss (Measured at 1 kHz, 600 ohms)	A Relay, 100 dB, minimum C Relay, 90 dB, minimum
Power Supply Input	115 vac ± 10 percent, 47.5 - 63.0 Hz, Single phase
Power Supply Output	5 vdc, 1.8A

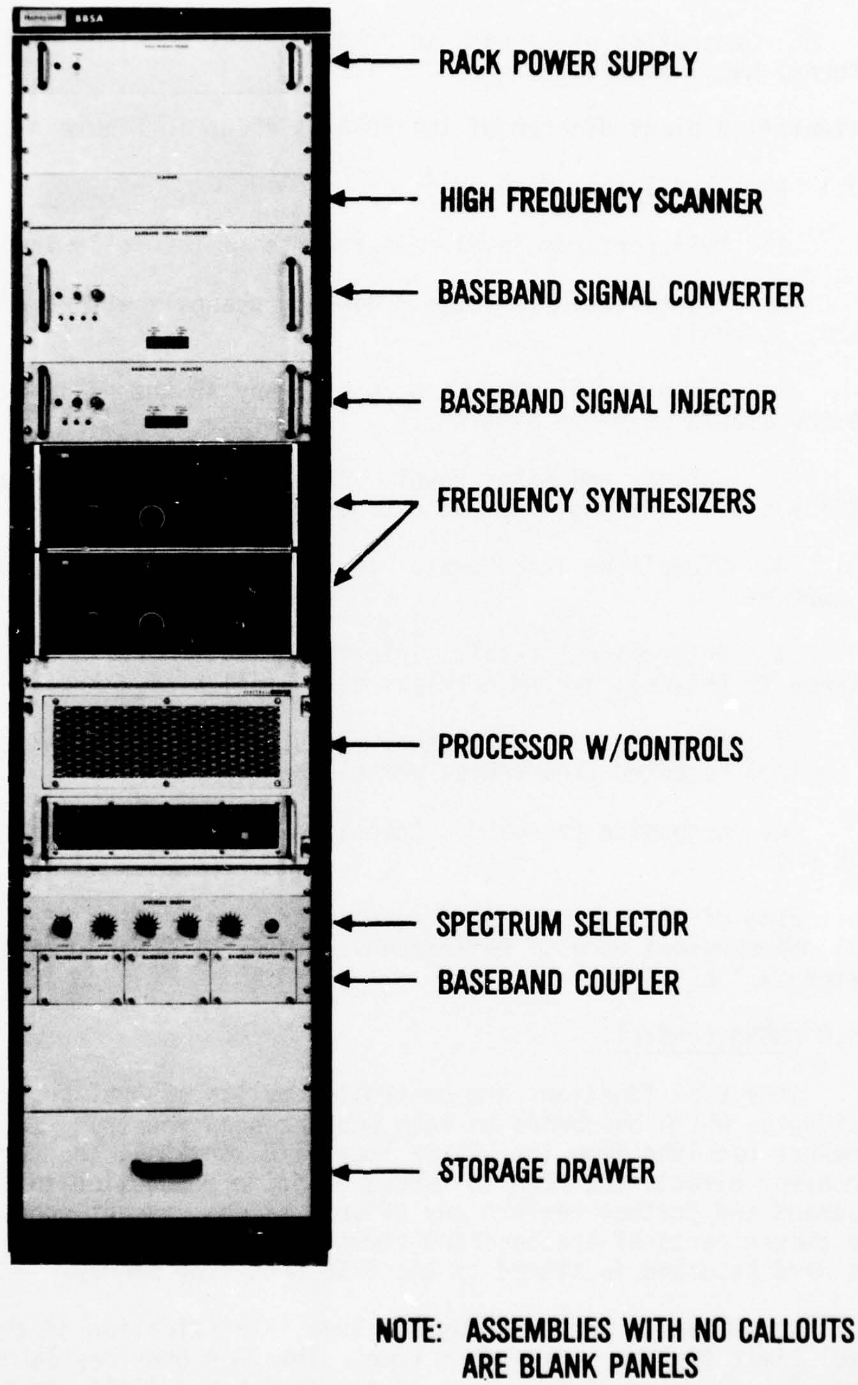


FIGURE 4-16. BASEBAND SIGNAL ANALYZER (BBSA)

d. Generation of signals to produce spectrum displays on an external oscilloscope.

A simplified block diagram of the BBSA is shown in Figure 4-17.

4.3.1 Baseband Signal Categories.

The BBSA performs level measurements of the following signal types:

a. Channel Level. Voice frequency channels with carriers at 4 kHz intervals.

b. Group Level. Groups occupying any 48 kHz of bandwidth with the low side a multiple of 4 kHz.

c. Carrier and Pilot Level. Pilots and carrier frequencies at multiples of 4 kHz plus the Group Continuity Pilot.

d. Signalling Tone Level. In-channel band signalling tones at 2600 Hz.

e. Interchannel Level. Interchannel level, with 800 Hz bandwidth, between VF channels having carriers at multiples of 4 kHz.

f. Out of Band Slot. Level measurement for a 3.1 kHz bandwidth at up to 5 selected frequencies per baseband.

g. Composite Baseband. Composite baseband level from 12 kHz to 5 MHz.

Monitoring of the baseband is accomplished by execution of eight automatic measurement modes. Definitions of the BBSA measurement modes are listed in Table 4-7.

4.3.2 BBSA Control.

The BBSA functions are controlled by its control processor, which designates which basebands to scan and the scan mode(s). In response to commands received from the NSS or local I/O terminal, the control processor directs the BBSA to make a bridging connection to a selected baseband and further perform any of several measurement scan types on the chosen parts of the baseband structure. The structure for each standard baseband is stored in the BBSA processor memory.

Commands to the BBSA must include identification of the expected level limit for the measurement type. The BBSA provides level measurements for any element in excess of the designated limit, or it may be commanded to output all levels measured. The BBSA translates to voice frequency (VF) any channel from the monitored baseband for external analysis by a PATE or other external test equipment. A single test tone can be injected at any frequency in a selected baseband by the

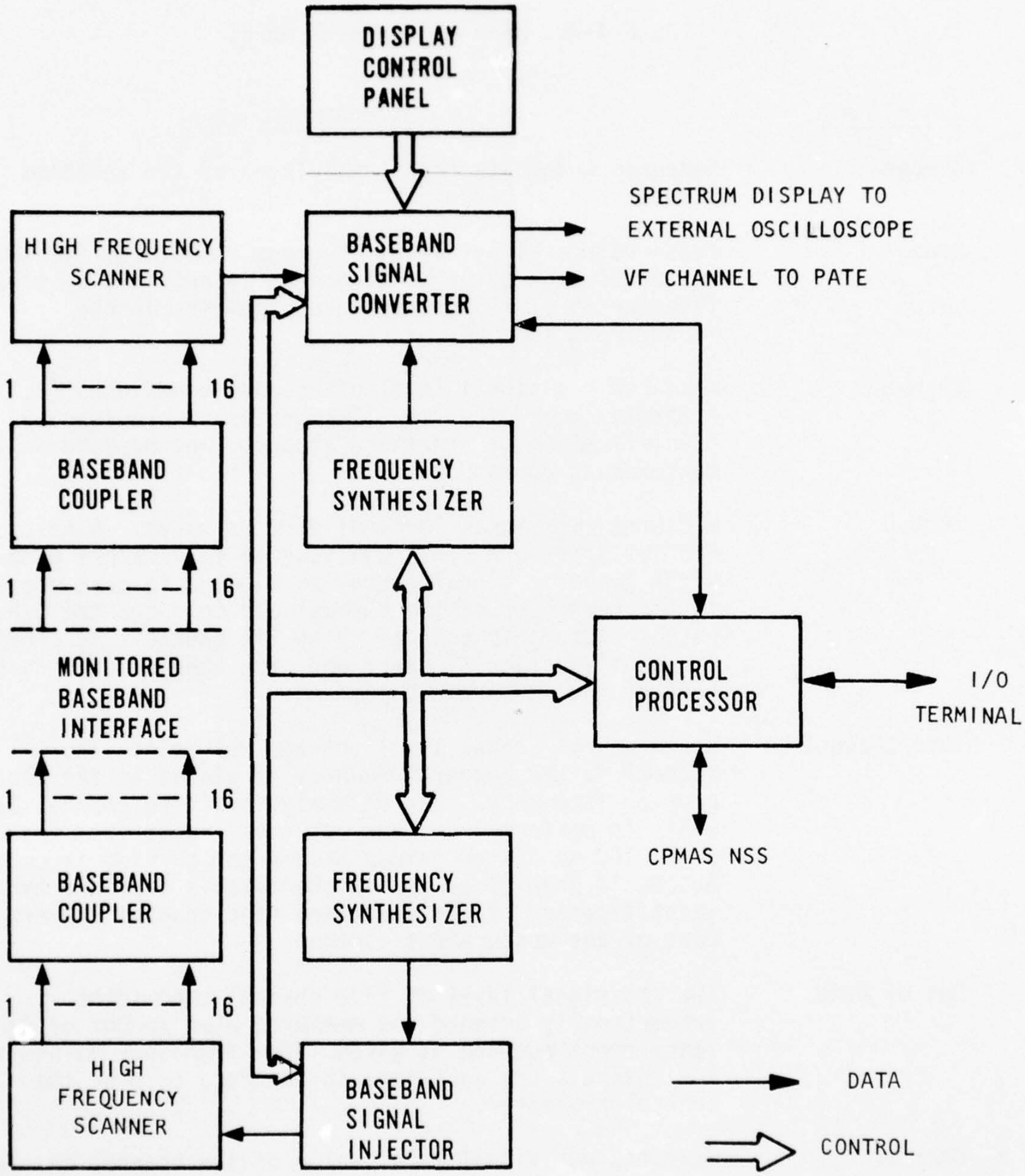


FIGURE 4-17. BBSA BLOCK DIAGRAM

TABLE 4-7. BBSA MEASUREMENT MODES

Scan Type	Measurement
Baseband	Measures composite rms signal level of the selected baseband. The bandwidth is 12 kHz - 5 MHz.
Group	Measures rms signal level of group bandwidths (48 kHz). Automatic scan of up to 51 groups is provided by identification of start and stop group numbers in the measurement command.
Channel	Measures rms signal level of channel bandwidths (3.1 kHz). Automatic scan of up to 612 channels is provided by identification of start and stop channel numbers in the measurement command.
2600 Hz	Measures rms signal level of 2600 Hz tones. A Fast Fourier Transform (FFT) analysis of the channel bandwidth compares signal energy at 2600 Hz to that present in the remainder of the channel and computes the S/N ratio. Automatic scan of up to 612 channels is provided by identification of start and stop channel numbers as part of the measurement command.
Interchannel	Measures rms signal level between channels. The 3.1 kHz channel filter center frequency is placed at the channel carrier frequency. An FFT analysis of the channel bandwidth is performed and the rms level value from the eight 100 Hz filter values around the carrier is computed. Automatic scan of up to 612 channels is provided by identification of the start and stop channel numbers as part of the measurement command.
Out of Band	The rms signal level of five channel bandwidths is automatically scanned and measured when an Out of Band measurement command is given. The frequency values for the channels are contained in the data base of the control processor.
Carrier	Measures rms signal level value of the channel carrier using the 16 Hz bandwidth filter. Automatic scan of up to 612 carriers is provided by identification of the start and stop channel carrier numbers as part of the measurement command.
Group Pilot	The rms signal level of the group pilot is measured using the 16 Hz bandwidth filter. Automatic scan of up to 51 groups is provided by identification of the start and stop group numbers as part of the measurement command.

Baseband Signal Injector (BBSI) function. The test tone provides channel type measurements at the baseband access point. Signal injection is accomplished through a bridge-on connection. Except at the injection frequency, the tone does not interfere with other traffic within the baseband.

The BBSA provides a spectrum display output capability. The following four spectrum display types can be selected via switches located on the Spectrum Selector Control Panel:

60 channel supergroup display

12 channel supergroup display

3.1 kHz channel display

3.1 kHz display located anywhere within the range from 12 kHz to 5 MHz

By using the local display Spectrum Selector Control Panel, the desired Baseband, Supergroup, Group, or Channel spectrum display can be observed on a local oscilloscope connected to the BBSA.

4.3.3 BBSA Major Components.

The following subparagraphs contain descriptions of the major components of the BBSA.

a. Baseband Couplers. Connection to the basebands, for monitoring and signal injection, is accomplished by separate active and passive couplers having the characteristics listed in Table 4-8. There are a total (maximum) of 32 couplers used with the BBSA. Sixteen are used to monitor 8 full duplex (send/receive) baseband appearances and 16 are used to inject test tone signals into the same baseband or on any other designated baseband. Only one monitor and one inject coupler can be active simultaneously. The couplers are designed to match the line impedance (nominal 75 ohms unbalanced) to the 50 ohm scanner input with $<$ 1.0 dB loading on the monitored baseband.

b. High Frequency Scanner. The scanner used with the BBSA is a 20 x 1 dry reed switch matrix. Control signals derived from the Baseband Signal Converter (BBSC) activate one switch closure at a time to select a Baseband Coupler. The signal picked up by the coupler is routed to the BBSC input.

c. Baseband Signal Converter. The Baseband Signal Converter (BBSC) provides the functions of a tuned voltmeter and calibrated single sideband receiver to measure both frequency and amplitude of signals in the 12 kHz to 5 MHz range. The BBSC measures signal levels within the bandwidths (bw) of: 48 kHz (group), 3.1 kHz (channel), 16 Hz (pilot). Channel bandwidths from any portion of the baseband can be translated to voice frequency for external analysis. In addition, the BBSC provides a spectrum output for display of supergroup, group, or channels on an external oscilloscope.

d. Baseband Signal Injector. The Baseband Signal Injector (BBSI) is a test tone generator used to inject a single frequency test tone within the baseband frequencies from 12 kHz to 5.0 MHz. The test tone is outputted to the baseband interface by a 1 x 20 dry reed switch matrix through passive, impedance matching, bridge-on couplers (Baseband Couplers).

e. Frequency Synthesizers. Two John Fluke, Model 6039A Frequency Synthesizers are used with the BBSA. One synthesizer is used to control the baseband signal level measurement related processes and the other is used to control the test signal injection process. The synthesizers are controllable in 1 Hz increments to any frequency within the 10.012 MHz to 15.000 MHz range. The BBSA uses 10.000 MHz as the frequency synthesizer standard. Frequency generation is by master oscillator and frequency division and multiplication is accomplished by digital and phaselock loop circuits.

f. Control Processor. The Control Processor (CP) is a Honeywell Model H-316R solid state computer. The computer contains an internally stored program, which controls the functions of the BBSA in response to commands received from the NSS or local I/O terminal. Input and output buses are 16 bit parallel. Data and commands are transmitted and received in USA Standard Code for Information Interchange (USASCII or ASCII) via a Data Line Controller Interface card inside the CP chassis.

4.3.4 BBSA Leading Particulars.

The leading particulars of the BBSA and its major components are summarized in Table 4-8.

4.4 ALARM REPORTING SUBSYSTEM (ARS)

The ARS, shown in Figure 4-18, automatically senses, displays, and transmits the status of two-state alarms. Under control of the Nucleus Subsystem or a local I/O terminal, the ARS can monitor and display the status of up to 500 two-state alarms, in groups of 50. The ARS consists of up to ten Alarm Sensors which can monitor and display up to 50 alarms each. Associated Alarm Displays provide continuous presentation of alarm states for local monitoring. In addition, a single Master Alarm Display is capable of selecting and displaying the alarm states of any one of the ten Alarm Sensors.

Multiple ARSs, or combinations of ARSs and MAUs, can share a single full duplex tandem operation bus in a daisy chain manner as represented in Figure 4-19.

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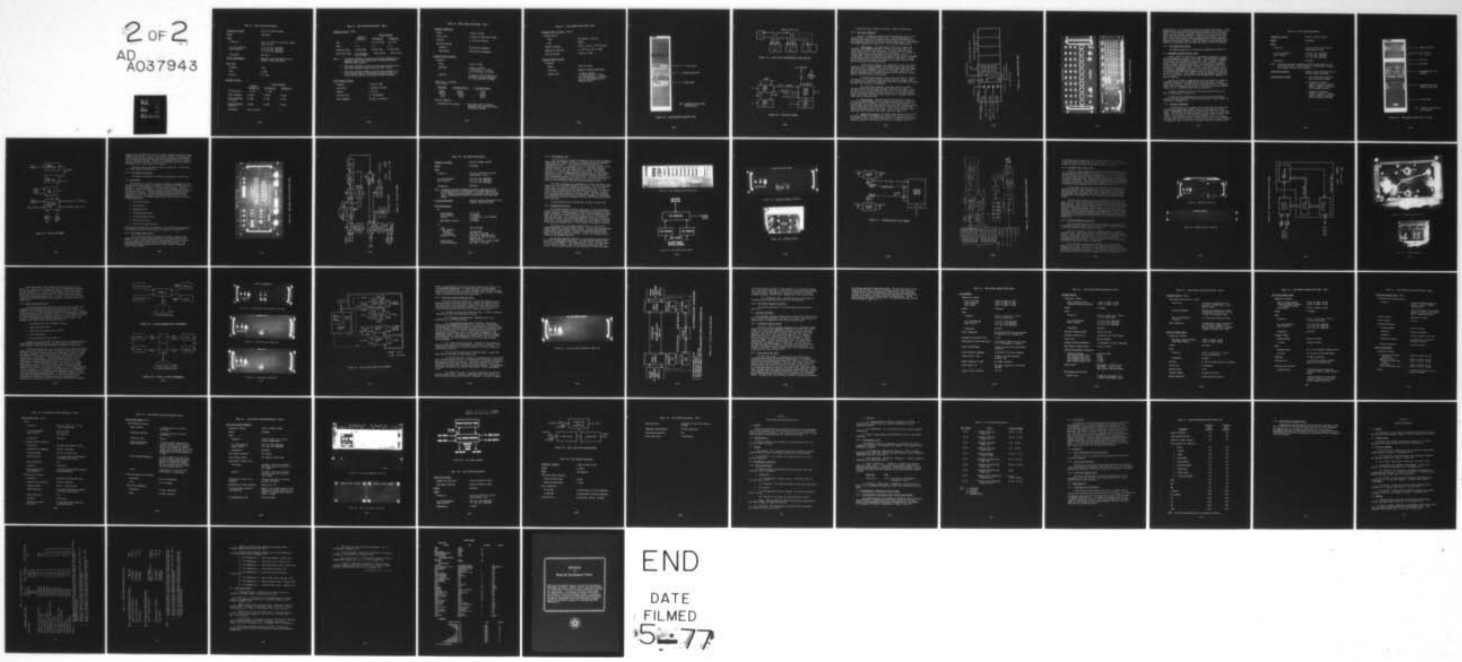

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TABLE 4-8. BBSA LEADING PARTICULARS

Dimensions (inches)	84.25H X 22.00W X 30.50D
Weight	580 pounds
Power	
Primary ac	115 v ac ± 10%, 47.5 to 63 Hz, single phase, 3 wire
dc, self-contained power supplies	+ 5 V dc ± 5%, regulated +15 V dc ± 5%, regulated -15 V dc ± 5%, regulated
Consumption	500 watts
Cabling Requirements	External cables fabricated on-site. Internal cabling furnished.
Self Check	
Frequency	1 MHz
Level	-30 dBm
Accuracy	± 0.1 dBm

Baseband Couplers

	Passive Coupler (1)	Active Couplers	
		Bridging (2)	Through (3)
Insertion Loss	1.0 dB	1.0 dBm	--
Input Impedance	75 ohms	75 ohms	75 ohms
Output Impedance (To Line)	75 ohms	75 ohms	75 ohms
Output Impedance (To BBSC)	50 ohms	50 ohms	50 ohms
Attenuation	15.5 ± 0.25 dB	--	--

TABLE 4-8. BBSA LEADING PARTICULARS (CONT.)

Baseband Couplers (Cont.)

	Passive Coupler (1)	Active Couplers Bridging (2)	Active Couplers Through (3)
Gain	--	16.3 ± 0.25 dB	15 ± 1 dB
VSWR	1:1.1	1:1.1	1:1.1
Frequency Range	12 kHz-5 MHz	12 kHz-5 MHz	12 kHz-5 MHz
Operational Range	plus 20 dBm to minus 20 dBm	minus 20 dBm	minus 20 dBm

Notes:
1. The passive couplers are used when monitoring basebands with composite signal levels greater than -20 dBm and with the Baseband Signal Injector.
2. The active (bridging) couplers are used when monitoring basebands with composite signal levels less than -20 dBm.
3. The active (through) couplers, which provide strappable 0 to 15 dB insertion gain to the monitored baseband signal, are used to monitor AN/UCC-4 multiplexer transmit basebands.

High Frequency Scanner

Frequency	12 kHz to 5 MHz
Input Level	-130 dBm to +20 dBm
Response	± 0.25 dB
Insertion Loss	0.1 dB (maximum)
Input Impedance	50 ohms ± 10 percent

TABLE 4-8. BBSA LEADING PARTICULARS (CONT.)

Frequency Synthesizer

Range	1 MHz to 160 MHz
Output Level	+3 dBm to +13 dBm into 50 ohms
Accuracy	± 1 dB over frequency
Spurious Response	
Harmonic	25 dB below fundamental
Non-harmonic	100 dB below fundamental

Baseband Signal Converter

Frequency:	
Range	12 kHz to 5 MHz
Amplitude	-9 dBm to -45 dBm ± 0.25 (60 kHz - 2.5 MHz) ± 0.5 (12-60 kHz, 2.5-5 MHz)
Stability	± 2 parts x 10^{-9}/24 hours as a function of ambient temperature (1 x 10^{-8} from -5°C to +55°C)

Selectivity of Software (FFT) Filters

Bandwidth	3 dB Width (min.)	60 dB Width (max.)
48 kHz	48 kHz	50 kHz
3100 Hz	3100 Hz	4 kHz
100 Hz	100 Hz	400 Hz
16 Hz	16 Hz	120 Hz

Spurious Response

Single/Pair Test Tone(s)	Not greater than -60 dB with respect to test tone level within the measured channel

TABLE 4-8. BBSA LEADING PARTICULARS (CONT.)

Baseband Signal Converter (Cont.)	
Remote Control	
Input	Asynchronous, 150 baud
Code	USASCII
Internal Standard	5 MHz $\pm$ 2 parts x 10^{-9} / 24 hours
Temperature Stability	1 x 10^{-8} from $-5^{o}C$ to $+55^{o}C$
Auxiliary Output	5 MHz at +13 dBm
Baseband Signal Injector	
Frequency:	
Range	12 kHz to 5 MHz
Stability	Same as Frequency Synthesizer
Output Level	-10 dBm to -60 dBm $\pm$ 0.25 dB (60 kHz - 2.5 MHz) $\mp$ 0.5 dB (12-60 kHz, 2.5-5 MHz) Into 75 ohms through passive Baseband Coupler.

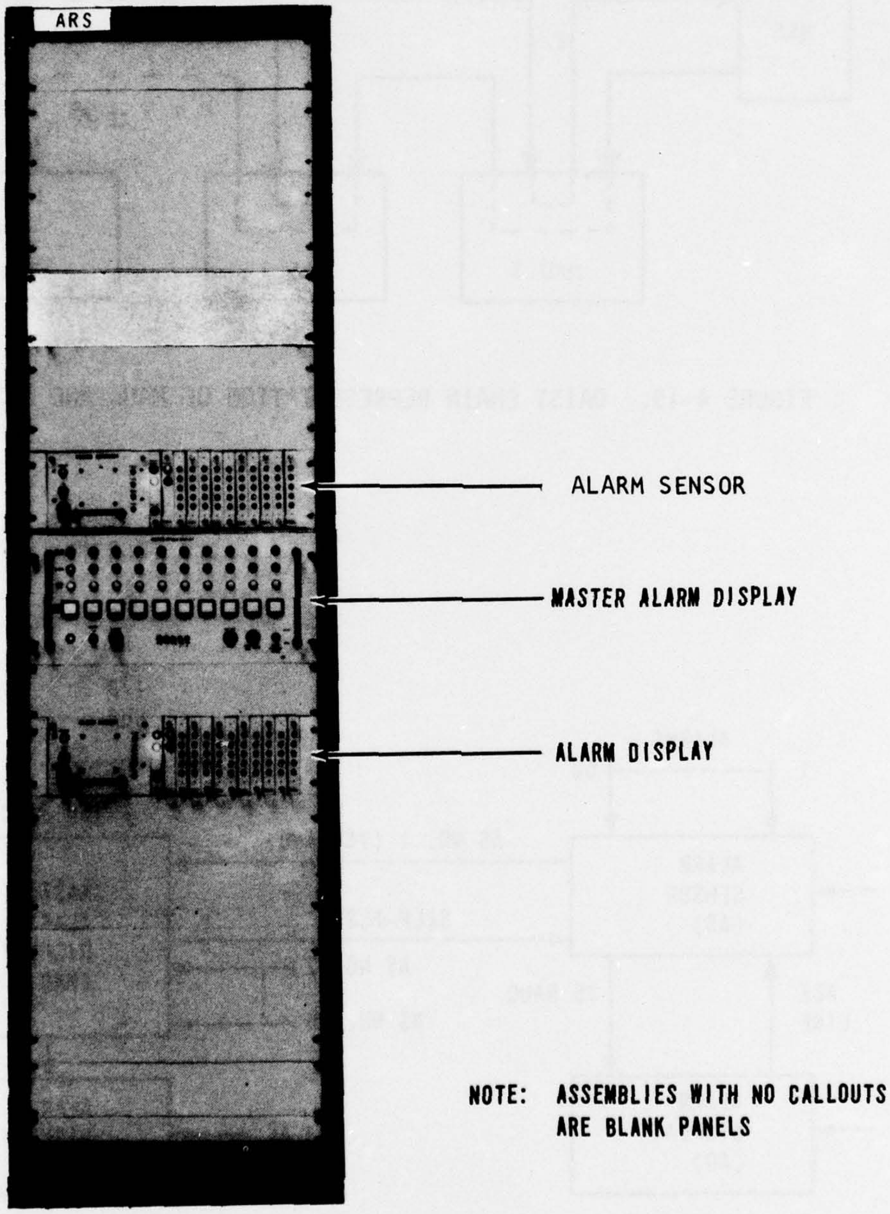


FIGURE 4-18. ALARM REPORTING SUBSYSTEM (ARS)

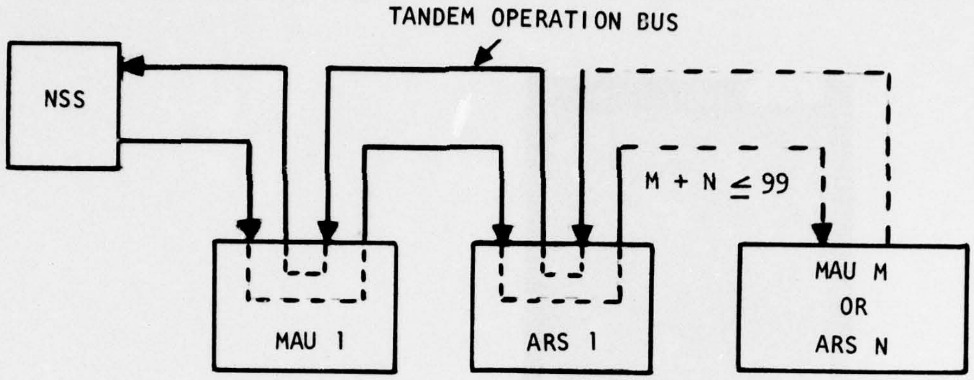


FIGURE 4-19. DAISY CHAIN REPRESENTATION OF MAUs AND ARSs

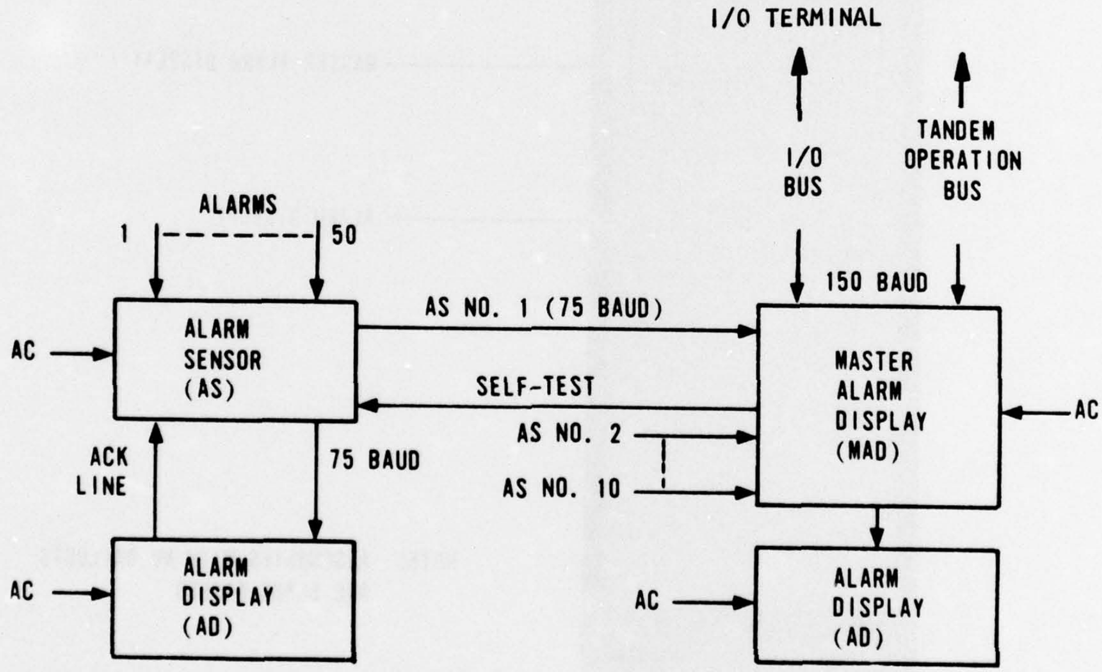


FIGURE 4-20. ARS BLOCK DIAGRAM

A simplified block diagram of the ARS is shown in Figure 4-20.

4.4.1 ARS Major Components.

The ARS is comprised of from 1 to 10 Alarm Sensors, from 1 to 11 Alarm Displays, and 1 Master Alarm Display. The ARS components are designed to be mounted in a standard 19-inch electronic equipment rack. Each component of the ARS has its own internal power supply. Descriptions of the ARS components are contained in the following subparagraphs.

a. Alarm Sensor. The Alarm Sensor (Figure 4-21) senses and displays up to 50 alarms modularly in groups of 10 front panel LED (light emitting diode) type indicators. The Alarm Sensor can stand alone and be used as a local alarm sensor and display. If a display is desired remote from the Alarm Sensor, an Alarm Display can be incorporated. Alarms are designated as major or minor and are programmed at the Alarm Sensor wiring block at the time of installation. Sensed major and minor alarm signals are routed to associated indicator lamps on the front panel of the Alarm Sensor.

The LED alarm indicators are controlled by blink logic which functions in the following manner: If an alarm occurs after the front panel ACK switch is depressed, the NON ACK front panel indicator lights and the LED alarm indicators flash at a 1.5 Hz rate. After the ACK switch is depressed, the flashing indicators glow continuously and the NON ACK indicator lamp is extinguished.

The MAJOR ALARM indicator lamp on the front panel is lighted and remains lit as long as at least one major alarm is sensed. When any alarm occurs the NON ACK front panel indicator lamp lights and remains lit until the ACK switch is depressed.

The Alarm Sensor contains a self-test circuit that when activated causes each LED alarm indicator to reverse its state. If a LED was lit, it is extinguished and vice versa. This self-test feature can be initiated by means of the SELF TEST switch on the front panels of the Alarm Sensor and Master Alarm Display, or by a command from the CPMAS Nucleus Subsystem (NSS).

b. Alarm Display. The Alarm Display (Figure 4-22) displays up to 50 alarms from an Alarm Sensor or Master Alarm Display in groups of 10 front panel LED indicators. Except for the self-test function, all Alarm Display front panel controls/indicators and their functions are the same as described for the Alarm Sensor. Activation of the SELF TEST switch on the Alarm Display front panel lights all the indicator lamps except the POWER indicator lamp, which should be already lit.

c. Master Alarm Display. The Master Alarm Display (Figure 4-22) has three functions. It multiplexes alarm status data from up to 10 Alarm Sensors into a co-located Alarm Display. It permits manual and/or automatic sequential selection and display of the status of up to 10

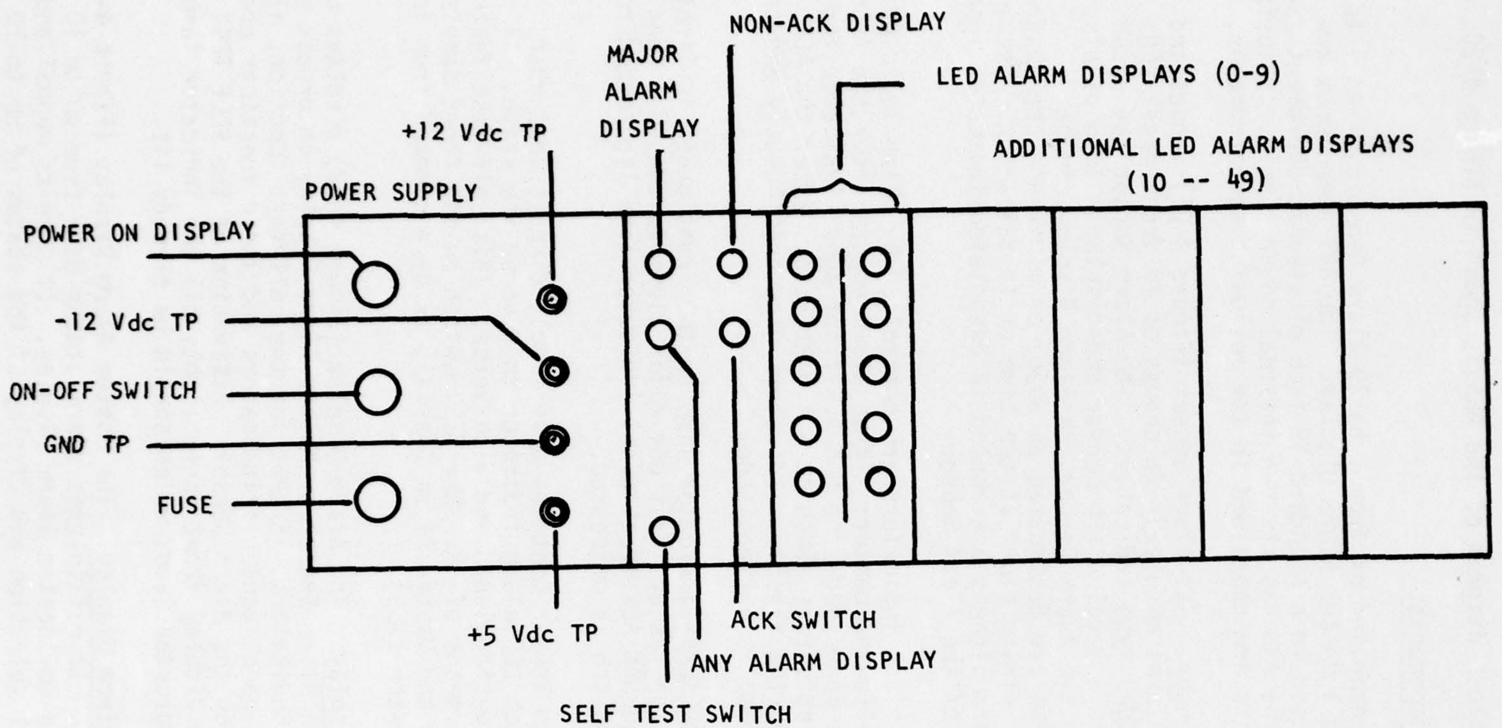


FIGURE 4-21. ALARM SENSOR FRONT PANEL

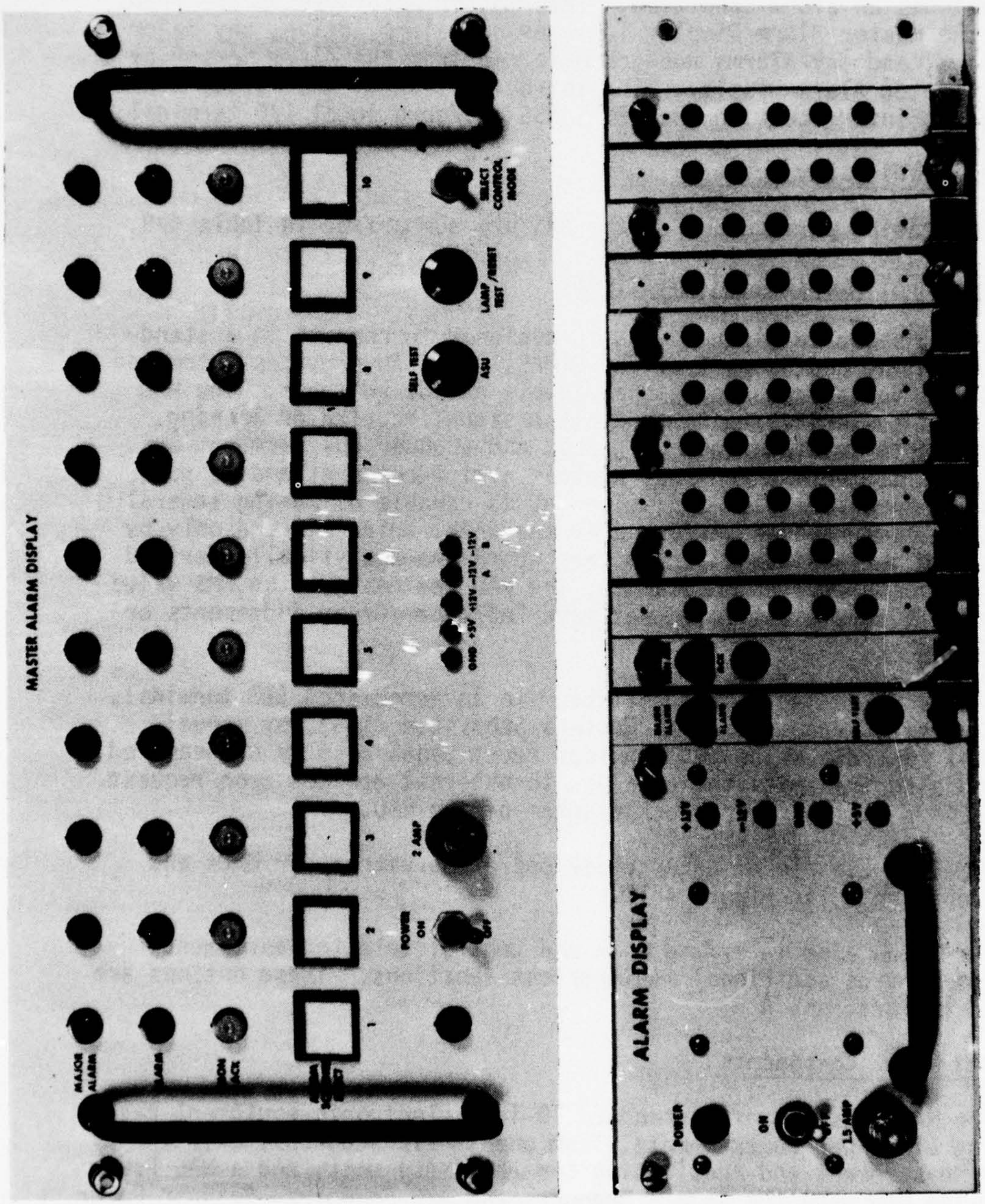


FIGURE 4-22. ARS ALARM DISPLAY PANELS

Alarm Sensors on its front panel and as associated Alarm Display. In the automatic mode, the associated Alarm Display displays each Alarm Sensor's alarms for approximately 20 seconds before switching to the next Alarm Sensor that has an alarm condition. Information displayed on the front panel of the Master Alarm Display includes any alarm active, any major alarm active, and any alarms non-acknowledged from the Alarm Sensor or a remotely located Alarm Display. The third function of the Master Alarm Display is to interface with the CPMAS NSS and/or a local I/O terminal.

4.4.2 ARS Leading Particulars.

The leading particulars of the ARS are summarized in Table 4-9.

4.5 MEASUREMENT ACQUISITION UNIT (MAU)

The MAU, shown in Figure 4-23, is designed to operate in a stand-alone environment and as part of the CPMAS. The MAU provides automated monitoring of voice frequency signal levels and dc voltages. The MAU also provides bus switching to accomplish signal routing or looping, access to remote input and output jacks, and scanner bus terminations. Unlike the PATE, the MAU does not contain a mini-computer and is not, therefore, a "programmable" SAE. The MAU is capable of making several of the basic measurements performed by the PATE, being limited only by not providing the additional parameters which are analytically derived by the mini-computer. As an example, the MAU can measure the RMS value of a VF signal level, but could not make Red/Amber/Green judgements or perform trending.

Control of the MAU is accomplished via an associated I/O terminal, commands received from the CPMAS Nucleus Subsystem (NSS), or manual front panel controls. The MAU provides front panel display of measured values and also transmits these values to external devices upon request. Figure 4-24 is a simplified block diagram of the MAU.

The MAU is capable of daisy chain operation with other MAUs and ARSs as represented in Figure 4-19.

The MAU can also interface with and control selected equipment options to provide additional monitor/test functions. These options are described in Paragraph 4.6.

4.5.1 MAU Major Components.

The MAU consists of a standard 19-inch electronic equipment rack containing a Scanner Power Supply, from one to six Scanners, a Jack Panel, a Measurement and Acquisition Control (MAC) unit, and a MAC Power Supply. The MAU uses the same A Scanners and A/C Scanners, Scanner Power Supply, and Jack Panel as the PATE (see Paragraphs 4.2.7c, 4.2.7b, 4.2.7e). The Measurement and Acquisition Control (MAC) is the command and processing unit for the MAU. The MAC contains the circuitry necessary to measure VF signal levels and dc voltages, generate and transmit test

TABLE 4-9. ARS LEADING PARTICULARS

Dimensions (inches)	84.25H X 22.00W X 30.50D
Weight	438 pounds
Power	
Primary ac	115 V ac ± 10%, 47.5 to 63 Hz, single phase, 3 wire
dc, self-contained power supplies	+ 5 V dc ± 5%, regulated +15 V dc ∓ 5%, regulated -15 V dc ∓ 5%, regulated
Consumption	220 watts

Note: The weight and power consumption figures listed above are for an ARS consisting of a Rack Assembly, an Alarm Sensor, a Master Alarm Display and two Alarm Displays.

Cabling Requirements	External cables fabricated on-site. Internal cabling furnished.
Characteristics Sensed	a. Dry contact relays normally open or normally closed. b. External dc voltages, normally present or normally absent, capable of supplying 10 mA through 500 ohms. c. External ac voltages, normally present or normally absent, capable of supplying 10 mA rms through 527 ohms.

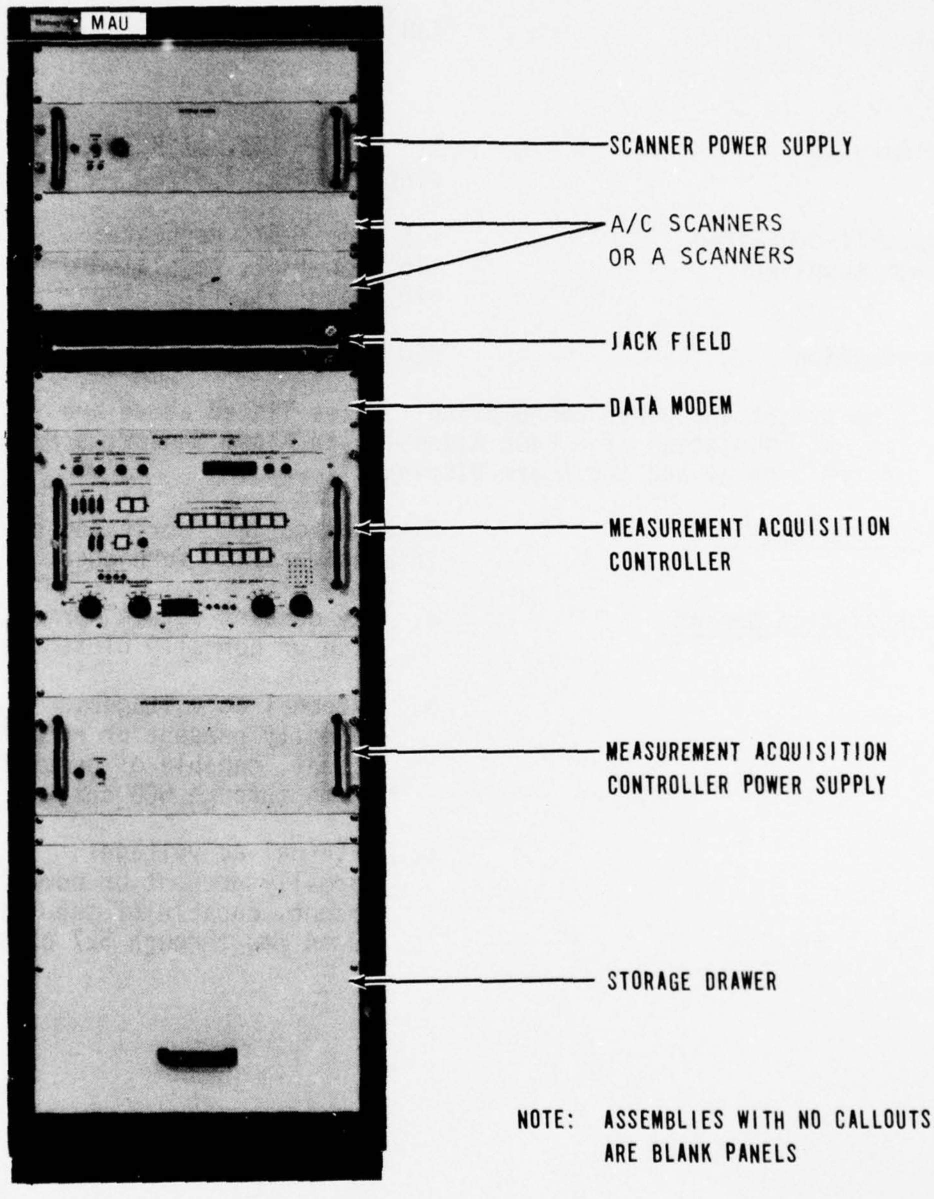


FIGURE 4-23. MEASUREMENT ACQUISITION UNIT (MAU)

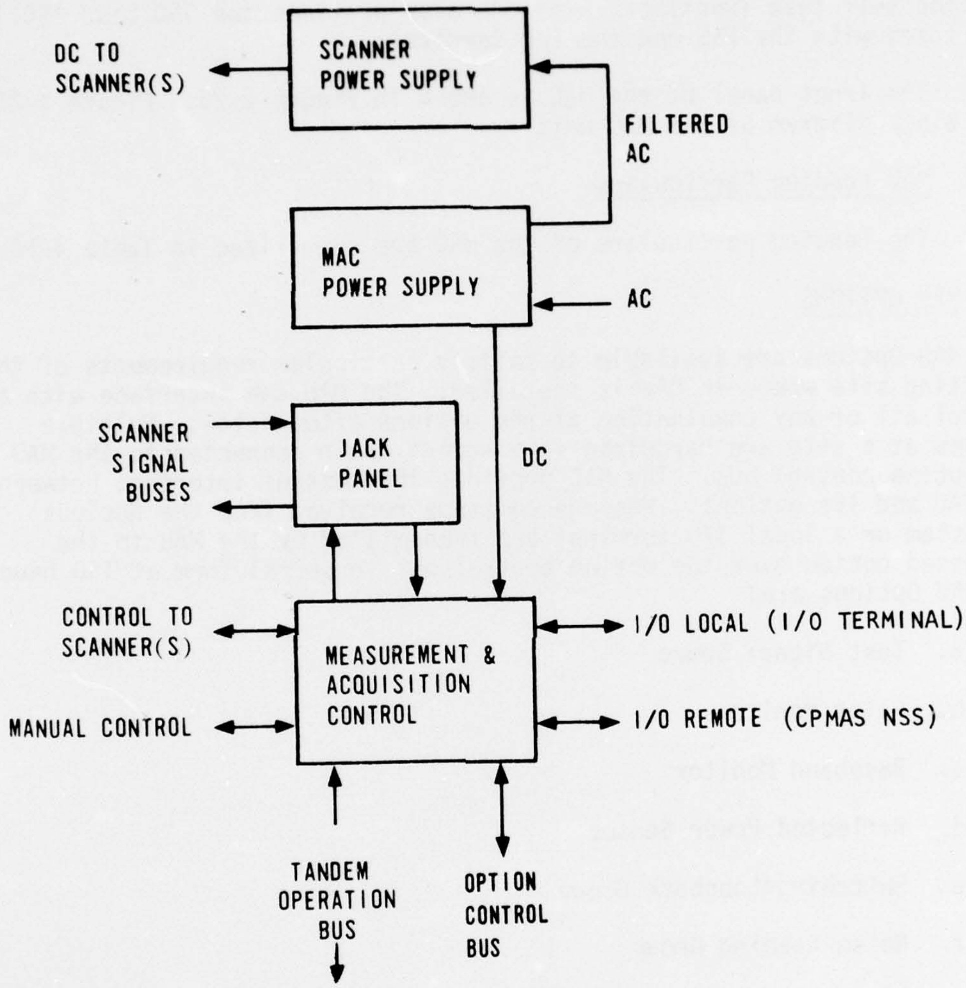


FIGURE 4-24. MAU BLOCK DIAGRAM

signals to the communication circuits, perform loopback functions, accept commands from the NSS or a local I/O terminal, control and interface with the A Scanners and A/C Scanners, and control and interface with options. The MAC provides front panel controls for implementing the basic measurement and self-test functions. The MAC also provides the 150 baud ASCII interfaces with the NSS and the I/O terminal.

The front panel of the MAC is shown in Figure 4-25. Figure 4-26 is a block diagram of the MAC unit.

4.5.2 MAU Leading Particulars.

The leading particulars of the MAU are summarized in Table 4-10.

4.6 MAU OPTIONS

MAU Options are available to satisfy particular requirements of the operating site where an MAU is installed. The MAU can interface with and control all or any combination of the options cited below. Multiple options at a site are hardwired in a series chain connected to the MAU via the option control bus. The MAC provides the control interface between the MAU and its options. Message commands received from the Nucleus Subsystem or a local I/O terminal are transmitted by the MAU to the addressed option over the option control bus in serial form at 150 baud. The MAU Options are:

a. Test Signal Source

b. Pilot Monitor

c. Baseband Monitor

d. Reflected Power Sensor

e. Switching/Loopback Group

f. Noise Loading Group

g. Idle Line Seizure Controller

A description of each option is contained in the following subparagraphs. The leading particulars of each option is summarized in Table 4-11.

4.6.1 Test Signal Source (TSS).

The TSS provides remote controlled or manually selectable test signals for use in out-of-service testing of VF communication circuits. The TSS is used in the out-of-service configurations of the PATE and is also used separately as an MAU option for manual applications. The capabilities and characteristics of the TSS are listed in Paragraph 4.2.7d of this report.

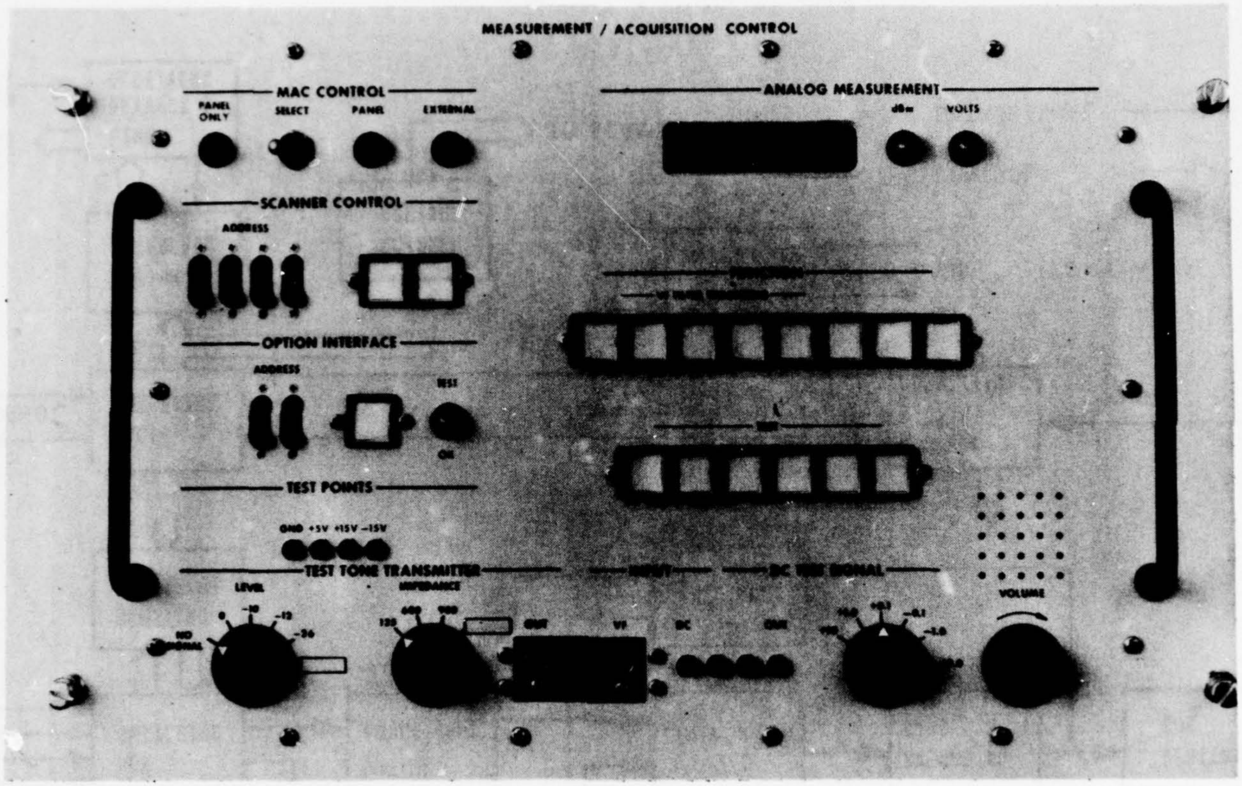


FIGURE 4-25. MEASUREMENT ACQUISITION CONTROL PANEL

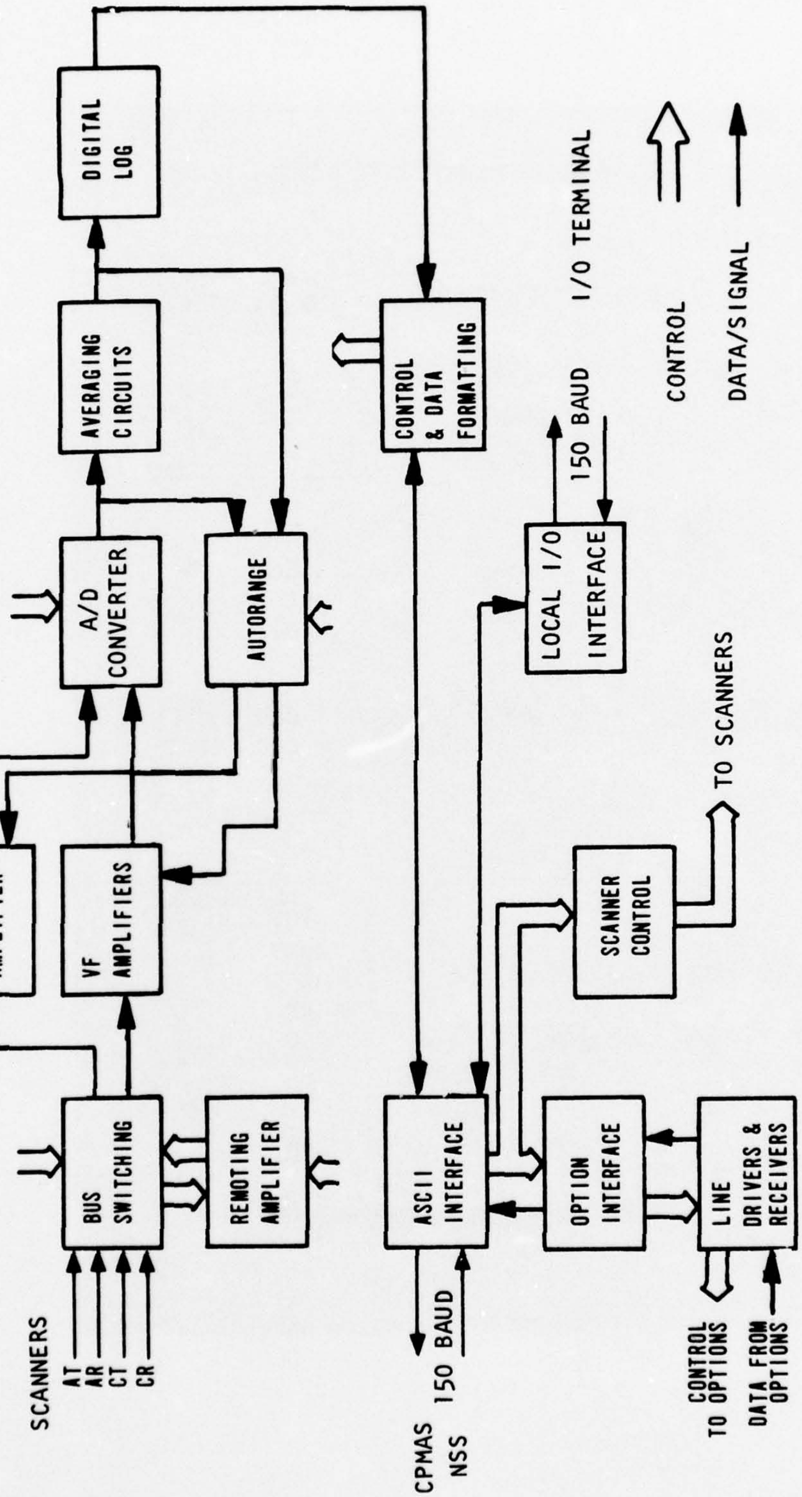


FIGURE 4-26. MAC BLOCK DIAGRAM

TABLE 4-10. MAU LEADING PARTICULARS

Dimensions (inches)	84.25H X 22.00W X 30.50D
Weight	510 pounds
Power	
Primary ac	115 V ac ± 10%, 47.5 to 63 Hz, single phase, 3 wire
dc, self-contained power supplies	+ 5 V dc ± 5%, regulated +15 V dc ∓ 5%, regulated -15 V dc ∓ 5%, regulated
Consumption	500 watts

Note: The weight and power consumption figures listed above are for an MAU consisting of a Rack Assembly, a Scanner Power Supply, four A Scanners, two A/C Scanners, a Test Signal Source, a Jack Panel, a Measurement & Acquisition Controller, and a MAC Power Supply.

Cabling Requirements	External cabling fabricated on-site. *Internal cabling furnished.*
VF/DC Measurements	
DC	
Voltage Range	+10 to -10V
Input Impedance	> 2 megohms
Accuracy	1 percent or ± 1 mv, whichever is greater
Measurement Interval	0.1 second
VF	
Level	-60 to +20 dBm
Input Impedance	
Bridging	> 10,000 ohms
Terminating	900, 600, or 135 ohms
Weighting Filters	3 kHz flat; C-Message; 50 to 4100 Hz, all with or without 2600 Hz notch
Signal Source	1 kHz at 0, -10, -12 and -26 dBm
Source Termination	900, 600, or 135 ohms

4.6.2 Pilot Monitor (PM).

The Pilot Monitor is used in conjunction with the PATE to measure phase jitter and frequency offset of a frequency division multiplexer (FDM) master oscillator. The PM measures 96 kHz and 64 kHz, as synchronizing pilots. It consists of a Pilot Translator Chassis, Pilot Interface Chassis, and Power Supply Chassis. The Pilot Translator function utilizes seven board positions in a scanner type chassis which has a 13 circuit board capacity (Figure 4-27). The remaining positions are used to accommodate the Switching/Loopback Group Control, another MAU option. The Pilot Interface Chassis contains a monitor point transformer located at the pilot source. The Power Supply Chassis contains two regulated dc power supplies ($\pm$ 15 vdc and +5 vdc) that power the Pilot Translator and the Switching/Loopback Control.

The Pilot Translator can accommodate up to ten pilot inputs, each requiring a Pilot Interface located at the source. The Pilot Translator selects one of the ten pilot inputs and translates it to 1 kHz for phase jitter and frequency offset measurement by the PATE. It consists of two digital control boards, two Form "C" scanner boards, an analog board, an oscillator board, and a resistor board. The Pilot Interface is a transformer which provides high bridge-on impedance to the measurement point while maintaining compatibility with the 135 ohm cable to the Pilot Translator.

A block diagram of the Pilot Monitor is shown in Figure 4-28.

4.6.3 Baseband Monitor (BM).

The Baseband Monitor furnishes measurements of three performance related ratio link parameters at the frequency division multiplex (FDM) receiver baseband. These parameters are the composite baseband rms power level, the radio pilot level, and noise level in noise slots above and below the data band. The noise level measurement works in conjunction with the Noise Stop Filter option implemented at the transmit end of the radio link. The BM provides a single analog dc output which is related to the measured parameter level. This dc output is measured by the MAU.

The BM consists of the Radio Interface Chassis (RIC) and the Baseband Parameter Converter (BBPC) chassis. The RIC houses the Baseband Coupler (BBC), Interconnection Panel, and RIC mountable subassemblies associated with other options. Figures 4-29 and 4-30 show the front panels of the BBPC and BBC, respectively. Figure 4-31 contains a block diagram of the Baseband Monitor.

The Baseband Parameter Converter is a multimode baseband receiver with true rms measurement capability. The BBPC measures the true rms level of five parameters of the composite input signal. The BBPC output is a balanced dc voltage. Full scale output for each signal mode is +4 vdc. The full scale outputs are the resultant of single tone inputs

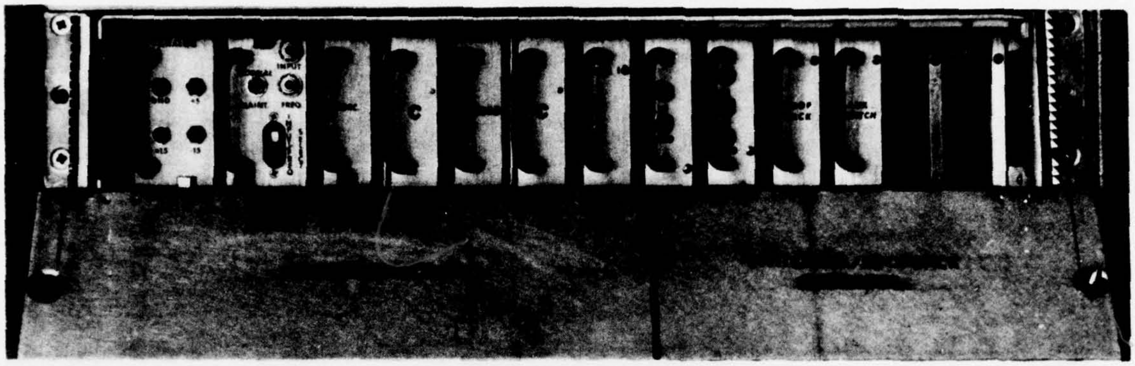


FIGURE 4-27. PILOT TRANSLATOR, FRONT PANEL OPEN

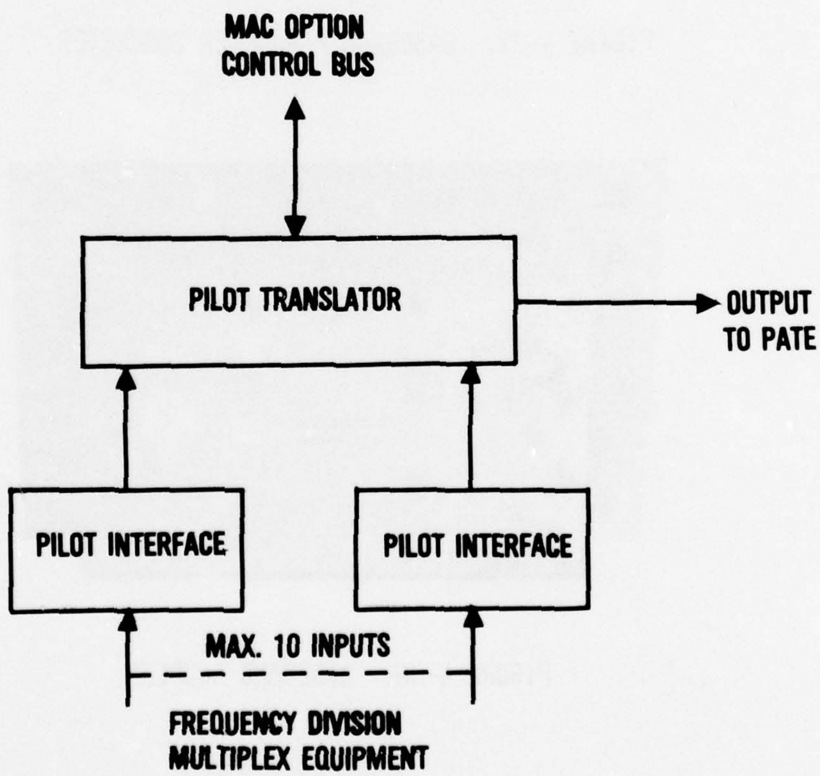


FIGURE 4-28. PILOT MONITOR BLOCK DIAGRAM

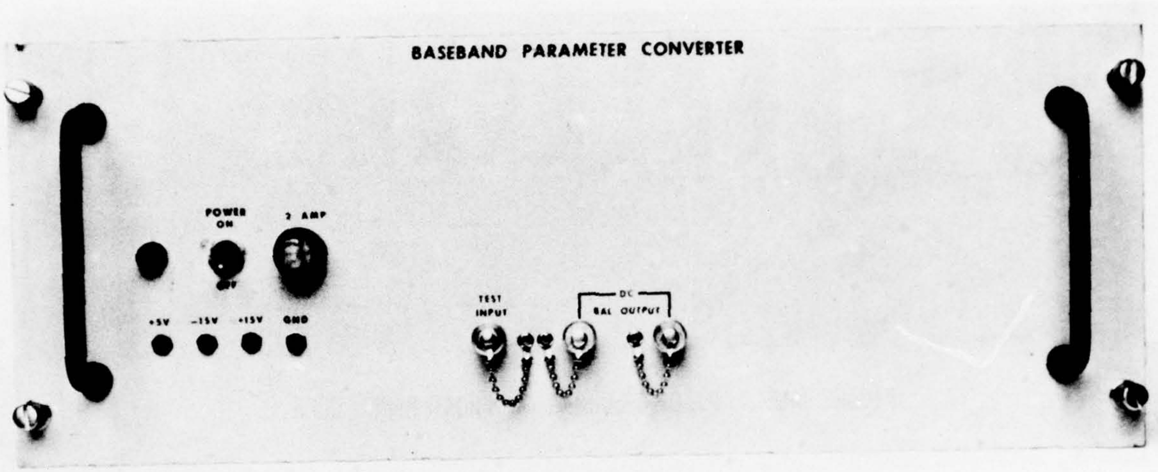


FIGURE 4-29. BASEBAND PARAMETER CONVERTER

FIGURE 4-30. BASEBAND COUPLER

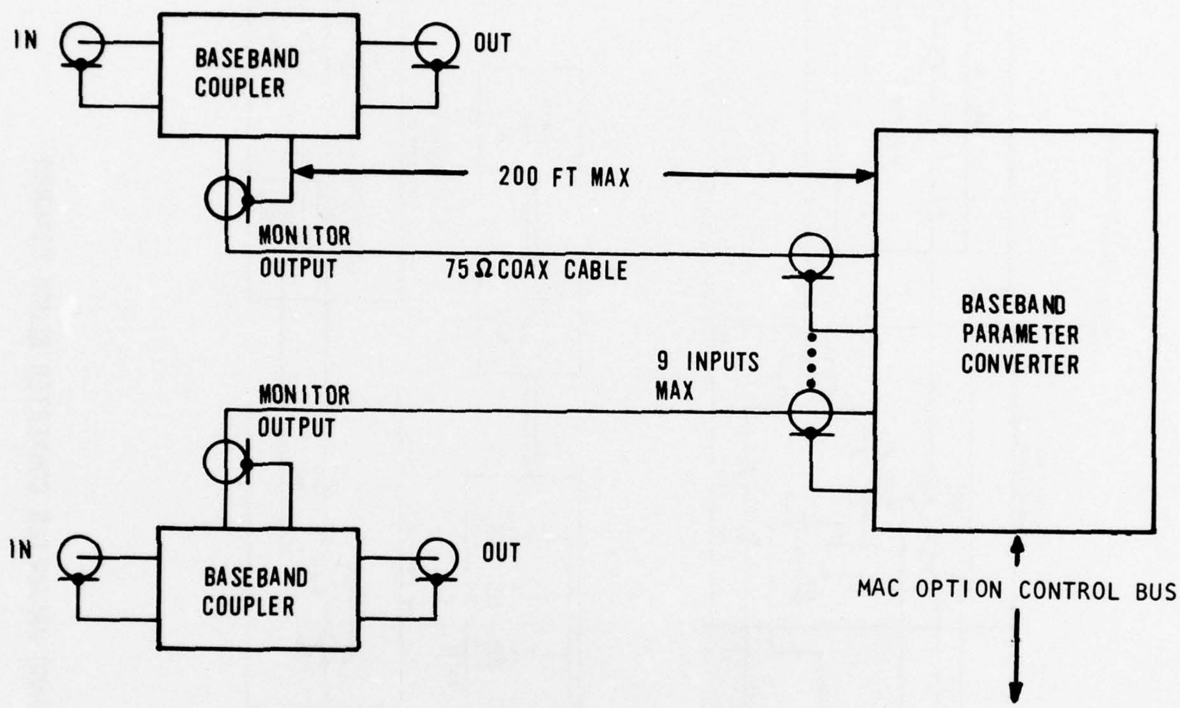


FIGURE 4-31. BASEBAND MONITOR BLOCK DIAGRAM

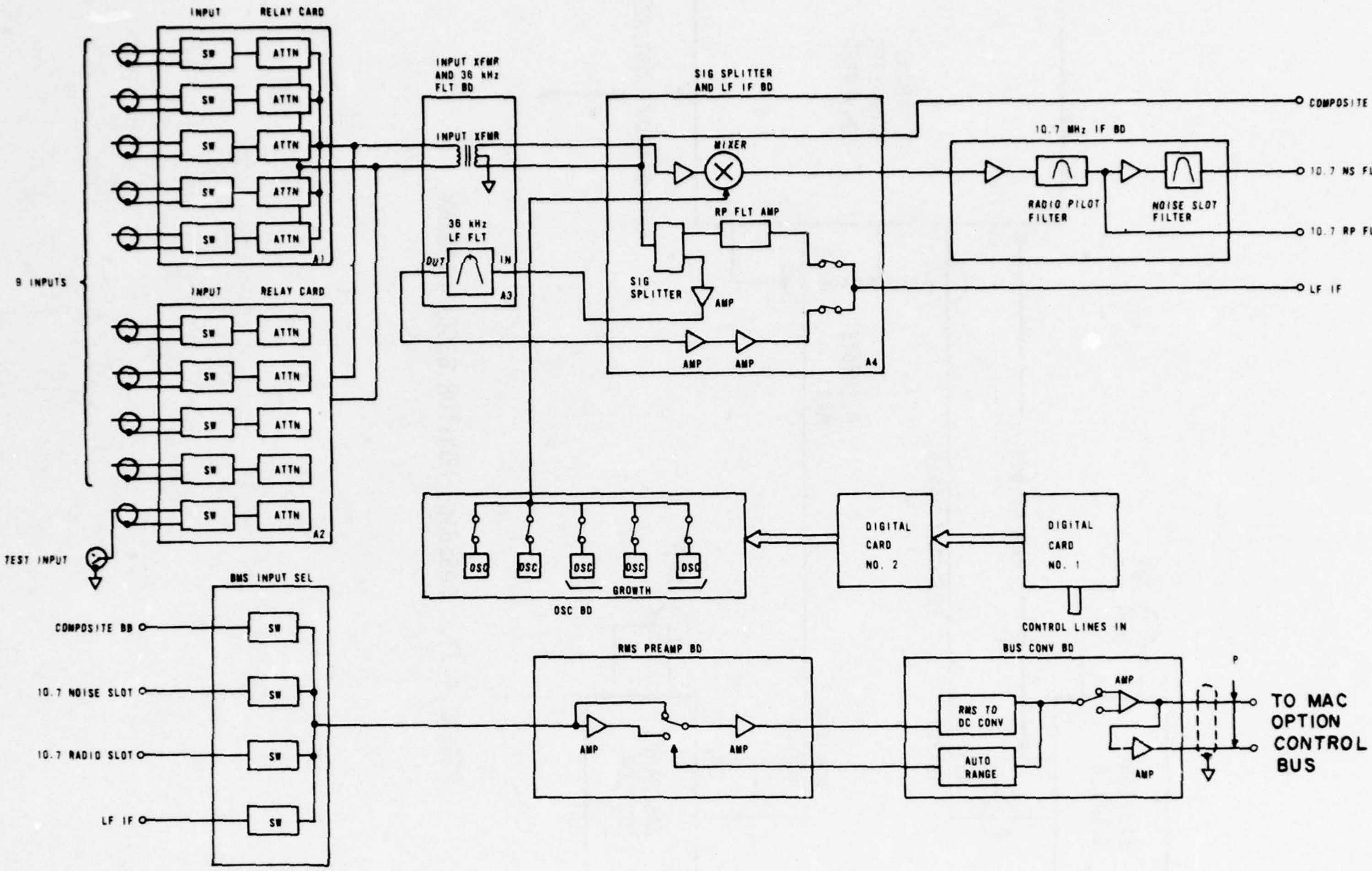


FIGURE 4-32. BASEBAND PARAMETER CONVERTER BLOCK DIAGRAM

at the BBC whose maximum levels are: composite baseband, +6 dBm; 12 kHz radio pilot, -9 dBm; and 4.7 MHz noise slot, -42 dBm. Figure 4-32 contains a block diagram of the Baseband Parameter Converter.

4.6.4 Reflected Power Sensor (RPS).

The RPS is used to measure the forward and reflected power within the microwave transmission feed for calculation of VSWR by the CPMAS NSS. The RPS consists of two chassis, the Power Meter Chassis (Figure 4-33) and the Microwave Interface Chassis (Figure 4-34). Both are mountable in standard equipment racks. They must be located within 200 cable feet distance of each other. The Microwave Interface Chassis must be mounted as closely as physically possible to the transmission feed monitor point. A functional block diagram of the RPS is shown in Figure 4-35.

The Microwave Interface accepts both forward and reflected power inputs and through a Radio Frequency (RF) coaxial switch routes the selected power to a second similar switch. The second switch permits the selected input or a dummy load to be connected to the power meter thermal mount. The dummy load is utilized for auto zeroing the power switch.

The Power Meter Chassis consists of a Hewlett-Packard Model 432C Power Meter, a control logic board, an interface logic board, and two power supplies. The interface logic board provides the interface between the MAU option control bus and the Power Meter. The control logic board performs the message decoding, switch control, and auto zero control functions. Data from the Power Meter is continuously being loaded into a parallel-to-serial converter located in the control logic board. When a data request is received from the interface logic board, the loading is inhibited and the data is transmitted to the MAU through the MAC option control bus.

4.6.5 Switching/Loopback Group (SLG).

The Switching/Loopback Group furnishes loopback of baseband and Intermediate Frequency (IF) signals to their source. Auxiliary switching is also provided for limited dc and VF signals.

The SLG is composed of three rack mounted chassis; the Radio Interface Chassis (RIC), the Switching Loopback/Pilot Translator Chassis (SL/PT), and the Power Supply Chassis. The RIC houses the Baseband Relay, IF Relay, Interconnection Panel, and RIC mountable subassemblies associated with other options. Figures 4-36 and 4-37 are front views of the Baseband Relay and IF Relay, respectively.

The SL/PT chassis contains the control cards to actuate the baseband or IF relays. The control cards share the chassis with the control cards for the Pilot Monitor. Card location A10 through A13 can be utilized for auxiliary switching of DC and/or VF signals. The controls and logic are similar to the ones required for Loopback Operation.

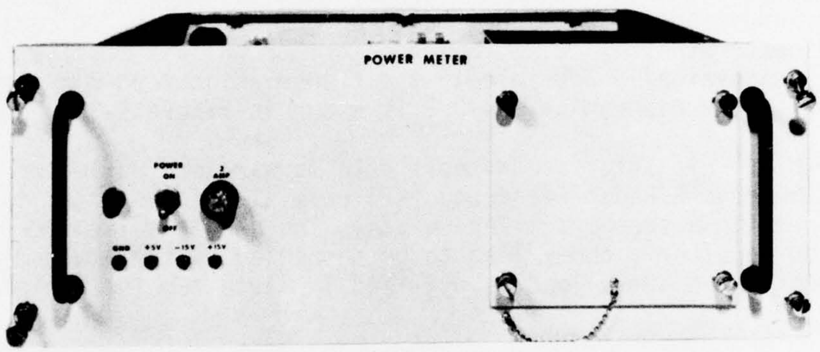


FIGURE 4-33. POWER METER, FRONT VIEW

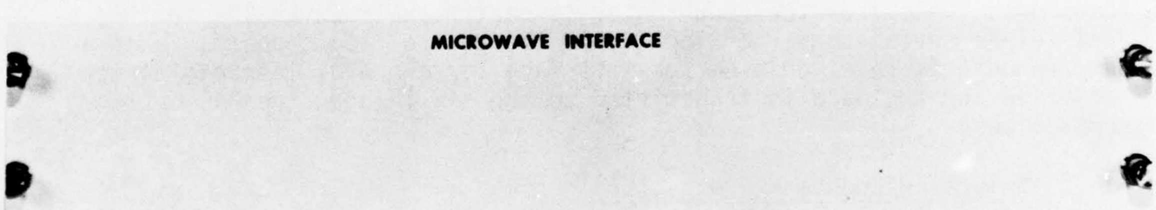
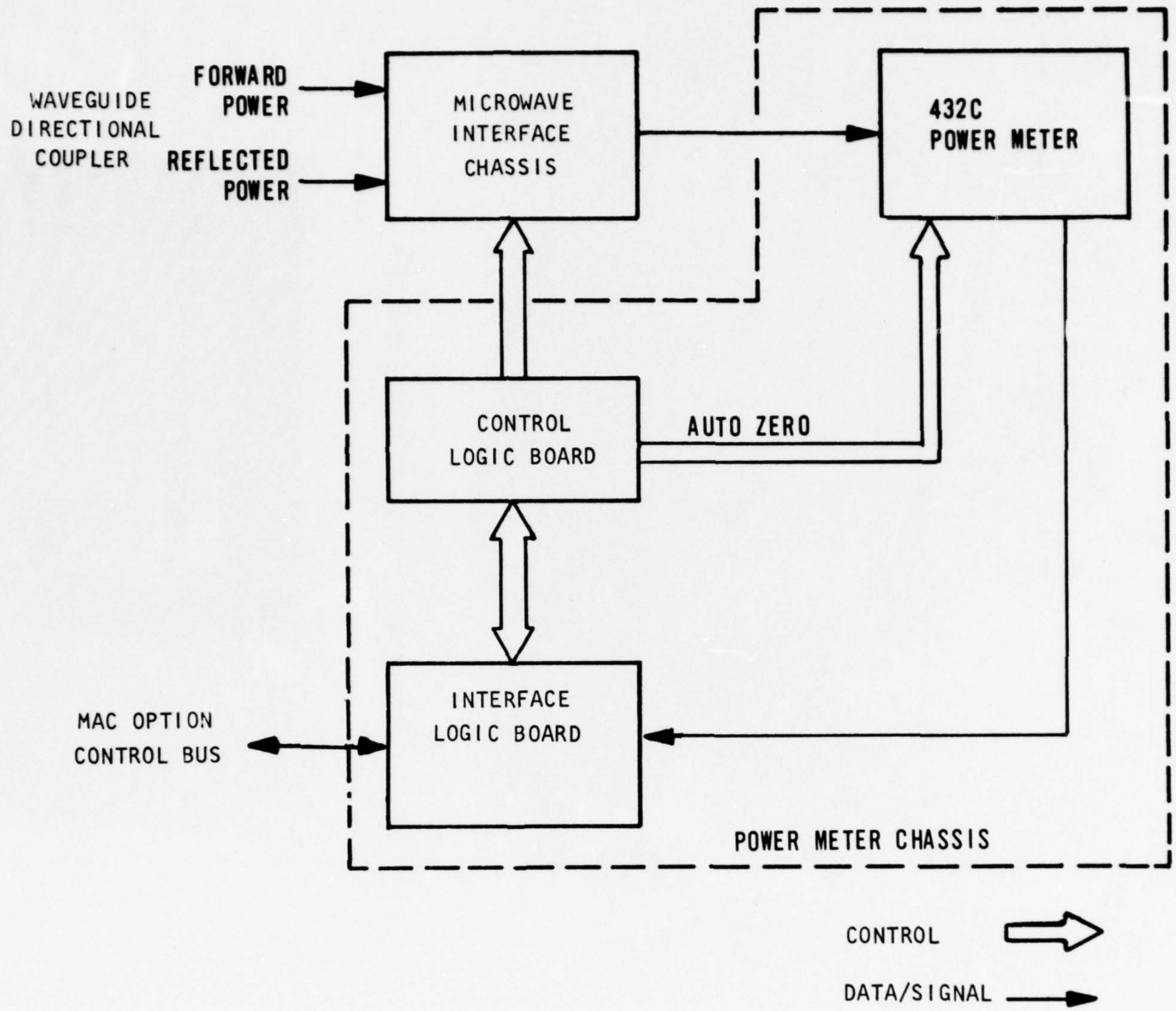


FIGURE 4-34. MICROWAVE INTERFACE, FRONT VIEW

FIGURE 4-35. REFLECTED POWER SENSOR BLOCK DIAGRAM



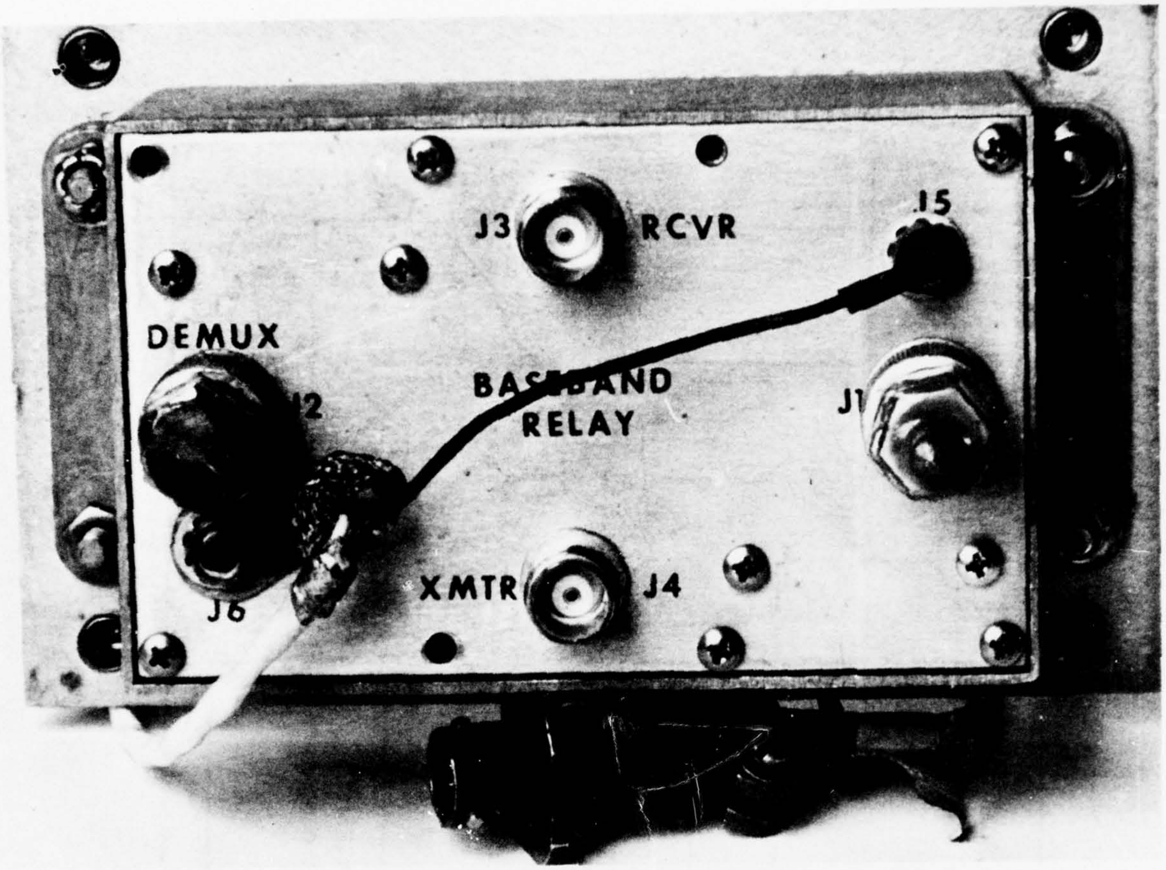


FIGURE 4-36. BASEBAND RELAY, REAR VIEW

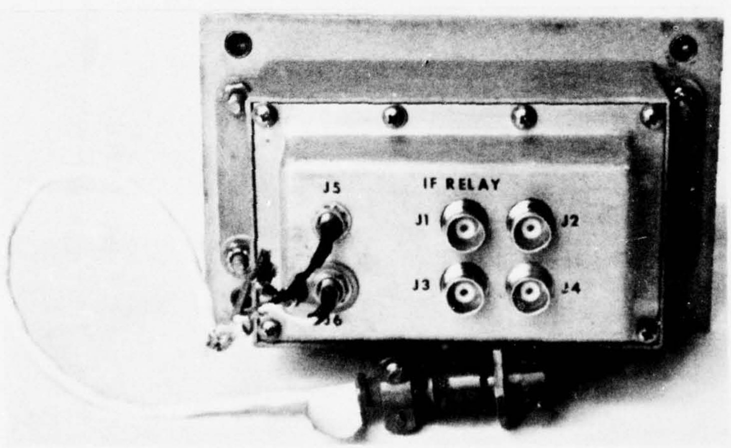


FIGURE 4-37. IF RELAY, REAR VIEW

The Baseband Relay (BBR) provides one way loopback of a full duplex link. The relay is located, electrically, between the multiplex and radio equipment. The Intermediate Frequency Relay (IFR) performs two-way loopback using a coaxial transfer switch to loop both links on either side of the relay break point. RFI filtering prevents control line pickup of unwanted signals by the IF relay. Figures 4-38 and 4-39 contain simplified interconnect block diagrams of a typical BBR and IFR, respectively.

4.6.6 Noise Loading Group (NLG).

The Noise Loading Group consists of five types of equipment interconnected to provide selective group and supergroup noise loading capability for a frequency division multiplexer (FDM) set. The NLG also provides selective in-band noise power ratio (NPR) measurements of unloaded groups and supergroups or of specific channels. The programmable amplitude and controlled spectral characteristics of the noise test signal allow testing of intermodulation distortion generated by FDM systems. The elements which comprise the Noise Loading Group are:

a. Group/Supergroup Noise Generator (G/SGNG).

b. Supergroup Switch (SGS).

c. Supergroup Switch Patch Panel (SGSP/P).

d. Group Switch (GS).

e. Group Switch Patch Panel (GSP/P).

Figures 4-40, 4-41 and 4-42 are front views of the Group/Supergroup Noise Generator, Supergroup Switch, and Group Switch, respectively. A block diagram of the Noise Loading Group is contained in Figure 4-43.

Interface to the FDM set is at the supergroup and group distribution frame by way of the SGSP/P and GSP/P. Provision is made within the SGSP/P and GSP/P, for manual lockout of selected supergroups or groups in order to prevent undesired circuit breaking or noise loading within the locked out channel. In the event of a power failure, all channels go to the normal through configuration. The Group/Supergroup noise source is furnished by a common pseudorandom digital noise generator. Level stabilizers are used to maintain the noise source output at 10 volts peak-to-peak. A 200 millisecond repetition rate and a 20 bit random word pattern through a ring counter provide $2^{20}-1$ different digital states to insure nearly pure white distributed noise and spectral content in 5 Hz increments. A bit interval of 200 nanoseconds, as provided by a stable clock oscillator, insures a uniform magnitude response for the Group and Supergroup frequency ranges. The generator output is divided into Group and Supergroup frequencies, by passive bandpass filters. Provisions for clearing of injected noise within the specified VF channels at the low and high ends of the Group and Supergroup frequency

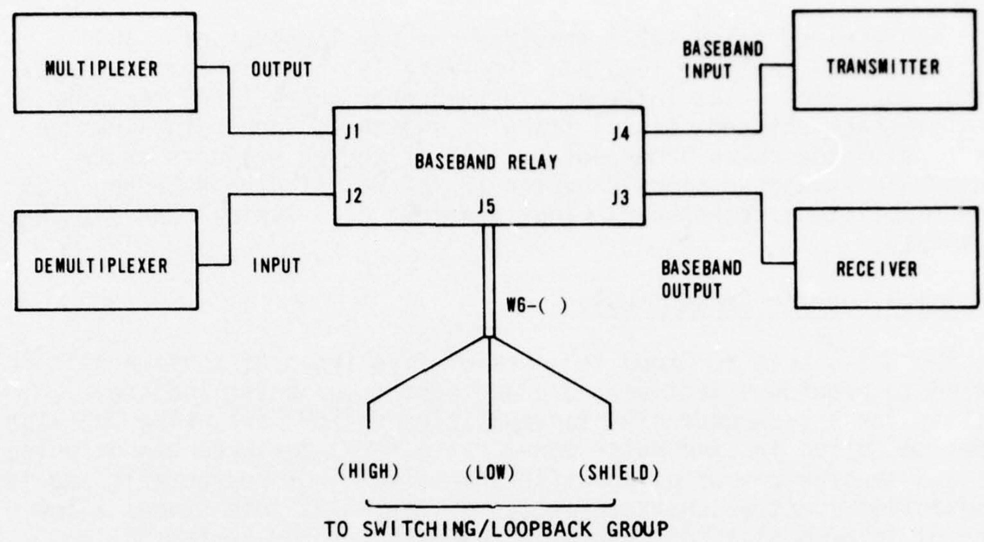


FIGURE 4-38. TYPICAL BASEBAND RELAY INTERCONNECT

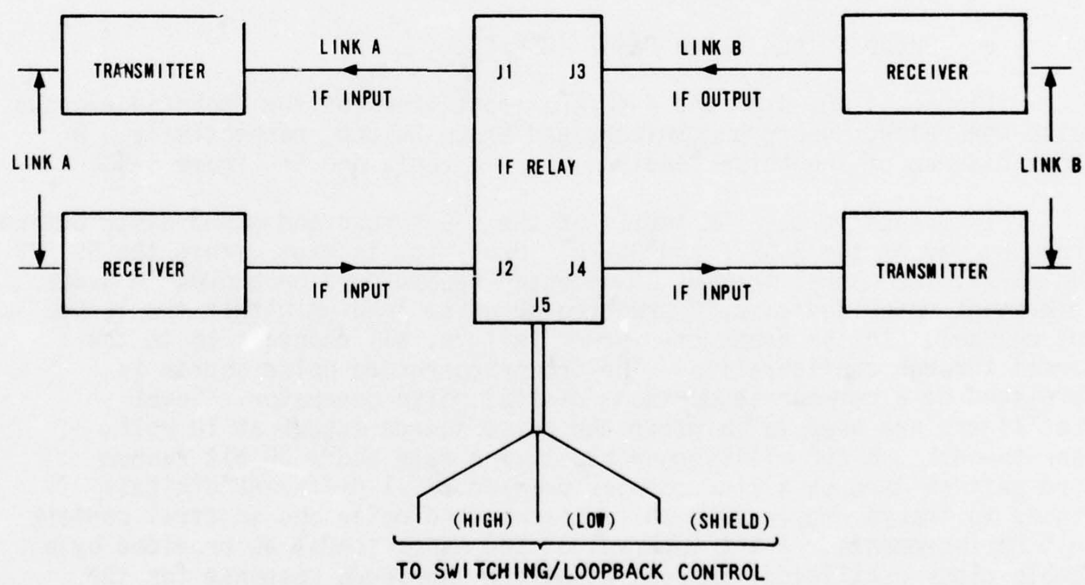


FIGURE 4-39. TYPICAL IF RELAY INTERCONNECT

FIGURE 4-40. GROUP/SUPERGROUP NOISE GENERATOR, FRONT VIEW

FIGURE 4-41. SUPERGROUP SWITCH, FRONT VIEW

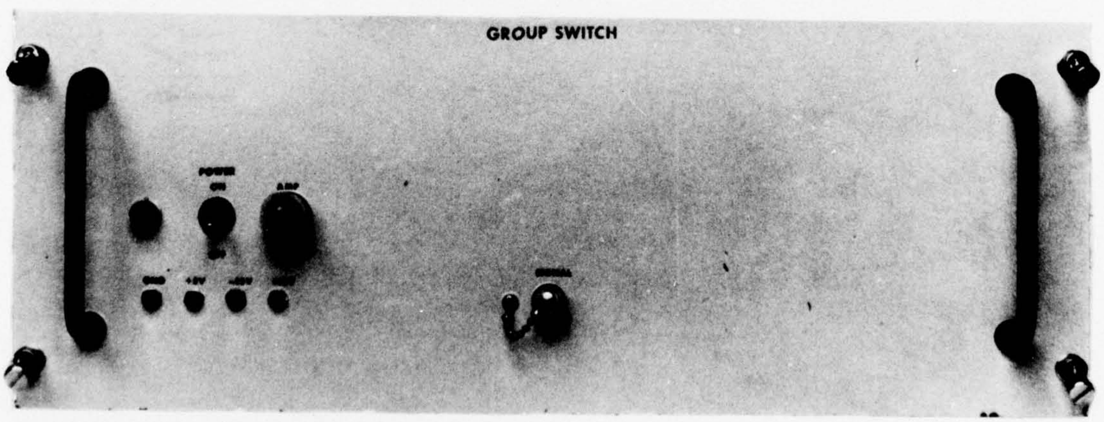


FIGURE 4-42. GROUP SWITCH, FRONT VIEW

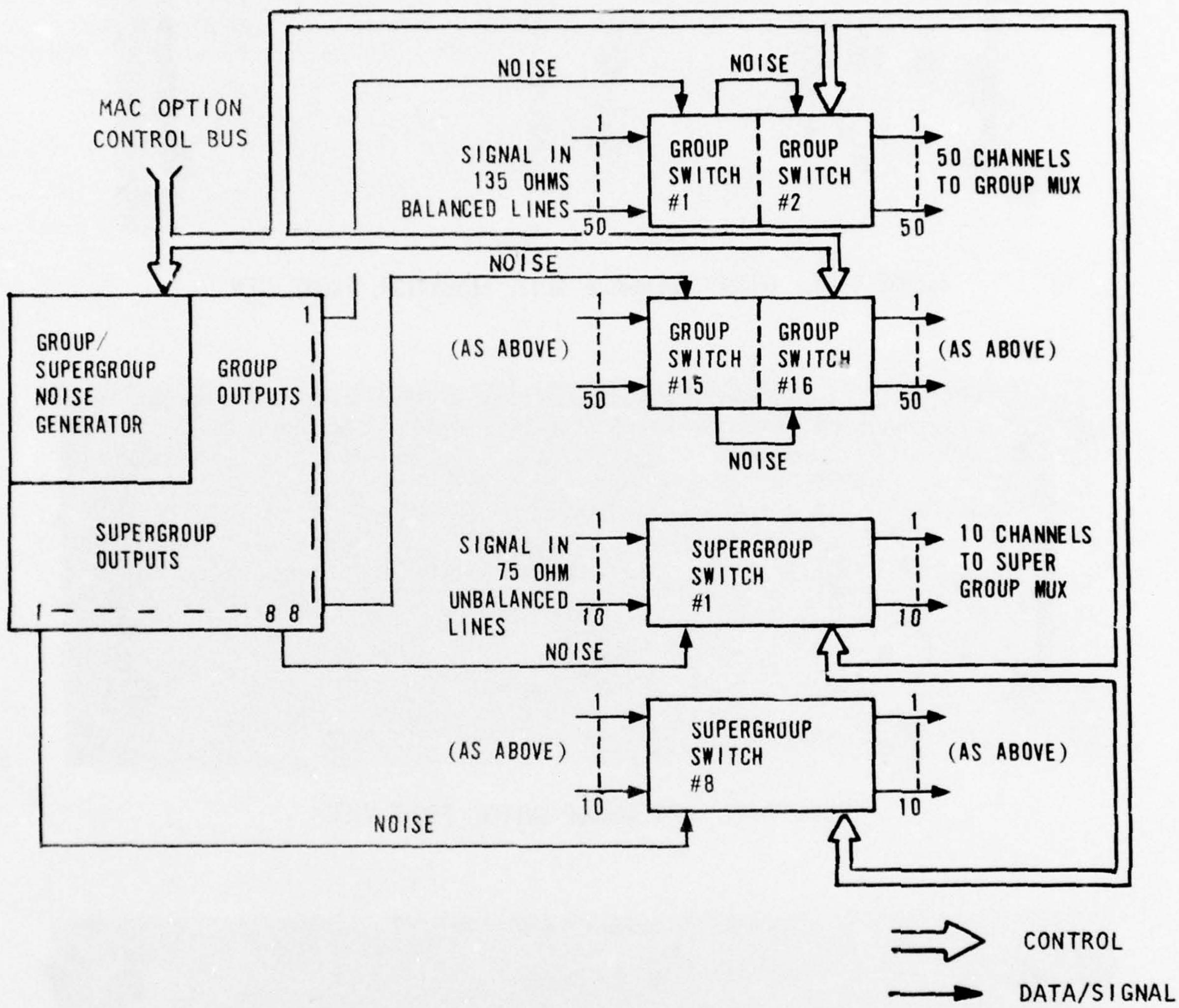


FIGURE 4-43. NOISE LOADING GROUP BLOCK DIAGRAM

bands is accomplished by notches at the band edges of each filter. Use of programmable attenuators of a reed relay design provide maximum isolation and repeatability. A single threshold level monitoring circuit senses the output from the attenuators to detect gross failures in output level or significant deviation from preset levels.

4.6.7 Idle Line Seizure Controller (ILSC).

The Idle Line Seizure Controller (Figure 4-44) determines the VF channel idle/busy status and seizes idle channels for channel testing. ILSC utilization is on interswitch Autovon trunks and subscriber lines with 2600 Hz SF (Single Frequency) signalling. Figure 4-45 contains a system configuration diagram of the ILSC interface and control.

a. The ILSC has three major operating modes: bridge-on detection, transparency seizure, and conditional seizure.

(1) Bridge-on detection mode - Determines the Tx and associated Rx line idle/busy status.

(2) Transparency seizure mode - Performs a single point seizure with replacement of the 2600 Hz SF signal during idle periods. The seizure and SF replacements occur on both transmit and receive lines. The ILSC monitors both lines before the seizure point to determine when a call for service occurs. A call for service causes the ILSC at the seizure end to restore the line for normal usage independent of the measurement status. Since there is no communication necessary between the seizure point and measurement end, the restoring time is less than 50 milliseconds, the time of detecting a call for service and reed relay switching.

(3) Conditional seizure mode - Identical to the transparent seizure except service is not restored until testing is complete. The conditional seizure mode is utilized to provide a two point seizure for out-of-service testing.

b. The ILSC can be used in three different modes: normal test mode, special test mode, or maintenance mode.

(1) Normal test mode - Seizure is performed during idle periods and is transparent to the user. The transparency is obtained by restoring the lines upon request for service. The normal usage mode is utilized for measurements of idle channel noise, channel gain, 2600 Hz phase jitter, phase hits, amplitude hits, dropouts, and noise frequency. The measurement is between the seizure point and any down stream bridge-on measurement point.

(2) Special test mode - Two point "conditional seizure" for out-of-service testing. Seizure is performed during idle periods and does not restore service until testing is complete. The 2600 Hz signals

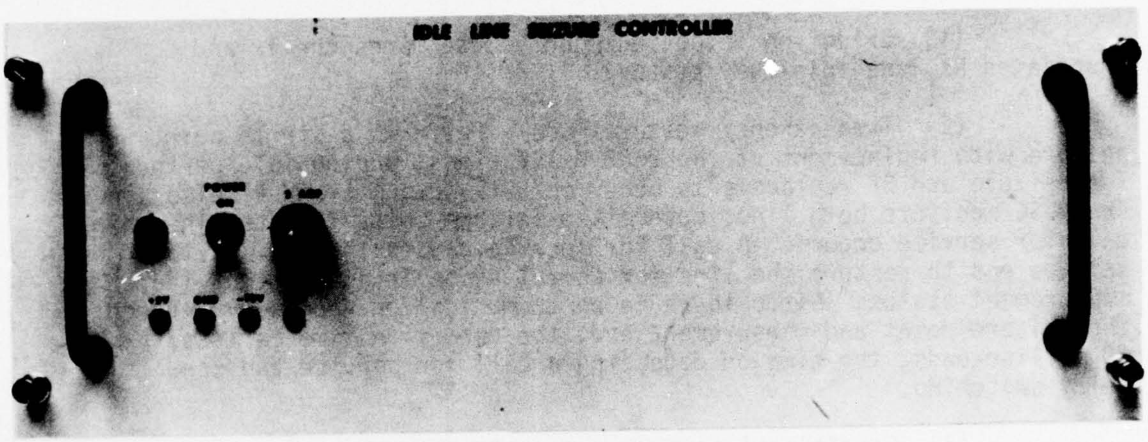


FIGURE 4-44. IDLE LINE SEIZURE CONTROLLER, FRONT VIEW

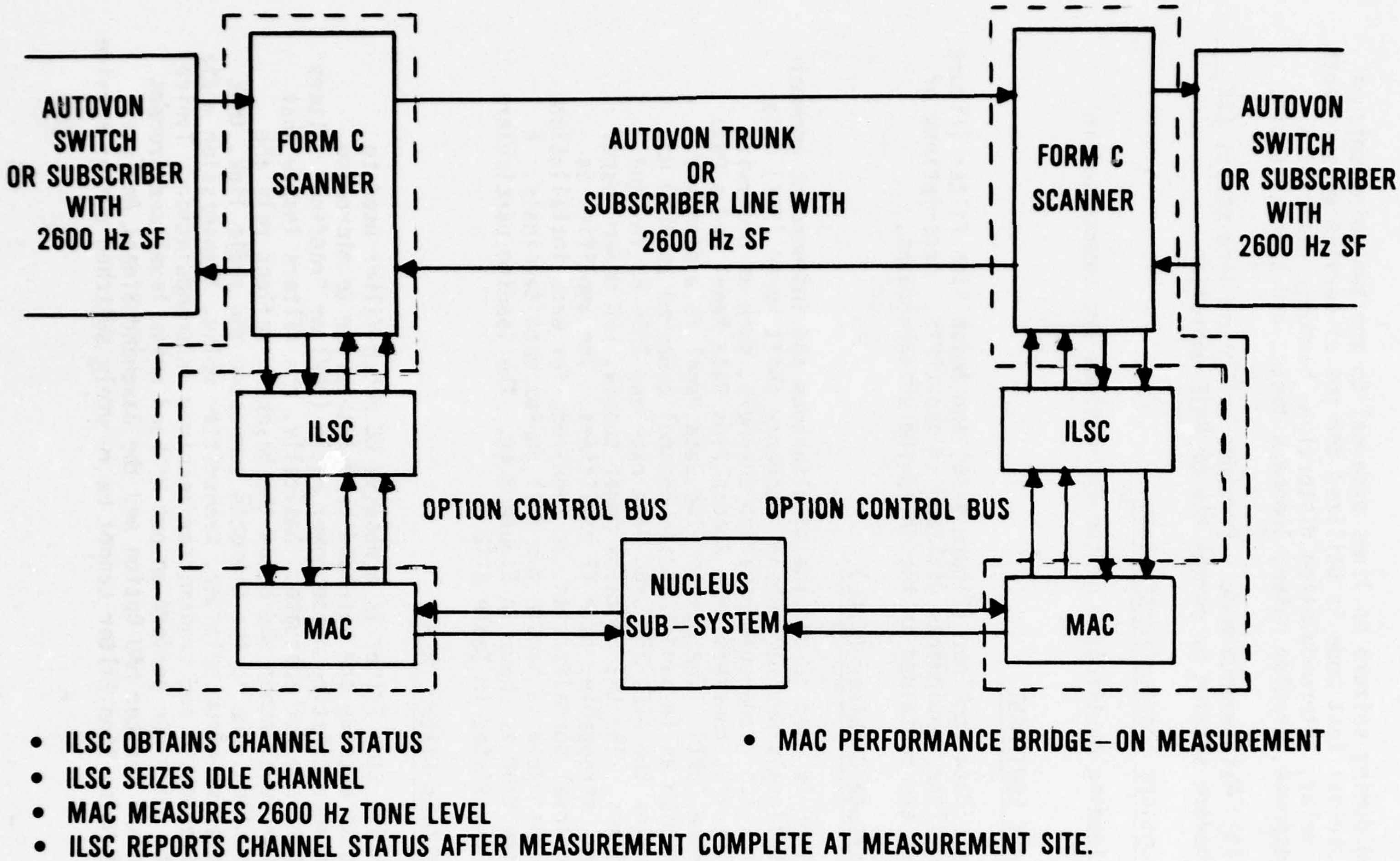


FIGURE 4-45. ILSC SYSTEM CONFIGURATION

are replaced during seizure on lines external to the two point seizure link. The special test mode is utilized for out-of-service measurements of envelope delay, intermodulation distortion, harmonic distortion, frequency response, impulse noise, loopback tests, and special tests.

(3) Maintenance mode - Provides bridge-on line status (if necessary) before seizing by normal MAU or PATE operation.

4.6.8 MAU Options Leading Particulars.

The leading particulars of the MAU options are summarized in Table 4-11.

4.7 ANCILLARY EQUIPMENT

The Voice/Data Combiner (Figure 4-46) and Noise Stop Filter (Figure 4-47) are ancillary equipments utilized in the CPMAS. Descriptions of these devices are contained in the following subparagraphs.

4.7.1 Voice/Data Combiner (V/DC).

The V/DC is used to provide simultaneous and independent communication of VF signals and narrowband frequency shift keyed (FSK) data signals over voice grade communication channels, such as orderwire circuits. The V/DC consists of a Speech Plus Data Panel and a Data Modem Interface (DMI). The Speech Plus Data Panel is a standard Lenkurt Unit with an in-band FSK data channel centered at 1920 Hz. The unit handles the ATEC 150 baud data rate and 2600 Hz in-band signalling tones. The DMI contains power supply, FSK modem boards and universal, strappable, gain VF amplifiers. The amplifier is utilized for level normalization, as required, for each installation. The DMI is expandable to handle two full duplex data terminals. A diagram of the V/DC is shown in Figure 4-48. The leading particulars of the V/DC are listed in Table 4-12.

4.7.2 Noise Stop Filter (NSF).

The Noise Stop Filter is a passive LC notch filter used to eliminate noise outside the baseband bandwidth prior to microwave transmission when existing noise power ratio (NPR) or "roofing" filters do not exist or are not adequate. Basically, the filters insure that received noise level above and below the baseband reflect only the noise contributions due to the elements composing the radio link, that is, transmitter spectrum splatter, transmitter noise, transmission media noise, receiver noise and transmitter/receiver intermodulation. Typical ATEC elements which can perform an out-of-band noise level measurement are the Baseband Monitor MAU Option and the Baseband Signal Analyzer (BBSA). The Noise Stop Filter cannot be remotely switched out-of-service but coaxial connectors allow manual bypass. The NSF units mount in the Radio Interface Chassis (RIC) to allow operation near the link radio. Although specific center frequencies as required per installation may be used, 36 kHz and 4.7 MHz units have been developed as satisfying the majority of microwave and tropo transmission requirements. The NSF configurations are shown in Figure 4-49. The leading particulars of the NSF are listed in Table 4-13.

TABLE 4-11. MAU OPTIONS LEADING PARTICULARS

PILOT MONITOR

Dimensions (inches)	
Pilot Translator	3.50H X 19.00W X 23.50D
Pilot Interface	1.75H X 19.00W X 17.25D
Power Supply	5.25H X 19.00W X 14.00D
Weight	42 pounds
Power	
Primary ac	115 V ac ± 10%, 47.5 - 63 Hz, 3 wire, single phase
dc, self-contained power supplies	+ 5 V dc, ± 5% regulated +15 V dc, ± 5% regulated -15 V dc, ± 5% regulated
Consumption	40 watts
Pilot Frequencies	96 kHz and 64 kHz (can be increased to measure up to 4 frequencies)
Frequency Translation Error	< 1 Hz
RMS Deviation Translation Error	< 20 percent relative to the input or 0.1 Hz whichever is greater
Input Voltage Range	5 vrms to 5 mvrms with overvoltage protection
Input Bridge-on Impedance	> 20K ohm at the Pilot Frequency
Output Level (1 kHz)	-5 dBm ± 5 dB into 600 ohms, balanced load
Output Impedance (1 kHz)	< 60 ohms, balanced
Input Capability	10 inputs (remoted up to 200 feet maximum)
Input to Input Isolation	> 70 dB

TABLE 4-11. MAU OPTIONS LEADING PARTICULARS (CONT.)

BASEBAND MONITOR

Dimensions (inches)	
Radio Interface Chassis	3.50H X 19.00W X 8.00D
Baseband Parameter Converter	7.00H X 19.00W X 20.75D
Weight	47 pounds
Power	
Primary ac	115 V ac ± 10%, 47.5 - 63 Hz, 3 wire, single phase
dc, self-contained power supplies	+ 5 V dc ± 5%, regulated +15 V dc ± 5%, regulated -15 V dc ± 5%, regulated
Consumption	30 watts
Baseband Frequency Range	300 Hz to 10 MHz
Baseband Insertion Loss	≤ 1 dB with ± 0.2 dB flatness
Input Level	250 mv maximum
Baseband VSWR and Impedance	1.10 maximum, 75 ohms, unbalanced
Measurement Frequency Range	8 kHz to 10 MHz
Standard Measurement Frequencies	
Composite Baseband	8 kHz to 10 MHz
Low Frequency Radio Pilot	12 kHz
Low Frequency Noise Slot	36 kHz
High Frequency Radio Pilot	3.2 MHz
High Frequency Noise Slot	4.7 MHz
Output Levels	High Range: +4.0V to +0.4V Low Range: -4.0V to -0.4V Auto Ranging, Balanced Output
Measurement Sensitivities	
Radio Pilots	-6 dBm0 nom; Baseband TTL of -15 dBm, 34 dB dynamic range

TABLE 4-11. MAU OPTIONS LEADING PARTICULARS (CONT.)

BASEBAND MONITOR (Cont.)

Measurement Sensitivities (Cont.)	
Noise Slots	-50 dBm0 nom, dependent on in-band noise loading level, 30 dB dynamic range
Composite Baseband	Standard DCS FDM Baseband Loading Formulations relative to a TTL of -15 dBm, 34 dB dynamic range
RMS to DC Conversion Linearity	± 0.5 dB over the dynamic range
Input Capability	10 addressable inputs; 9 Baseband Coupler inputs (remoted up to 200 cable feet maximum) 1 Baseband Parameter Converter test input

REFLECTED POWER SENSOR

Dimensions (inches)	
Microwave Interface Chassis	3.50H X 19.00W X 10.50D
Power Meter Chassis	7.00H X 19.00W X 20.00D
Weight	50 pounds
Power	
Primary ac	115 V ac, ± 10%, 47.5 - 63 Hz, 3 wire, single phase
Consumption	50 watts
Accuracy	< 1 dB, for inputs above 5 microwatts
Sensitivity	5 microwatts
Dynamic Range	30 dB
Frequency Range	4.4 GHz to 8.2 GHz
Remote Capability	≤ 200 cable feet (total)

TABLE 4-11. MAU OPTIONS LEADING PARTICULARS (CONT.)

SWITCHING/LOOPBACK GROUP

Dimensions (inches)	
Radio Interface Chassis	3.50H X 19.00W X 8.00D
Switching Loopback Control/ Pilot Monitor Chassis	3.50H X 19.00W X 23.50D
Power Supply	5.25H X 19.00W X 14.00D
Weight	27 pounds
Power	
Primary ac	115 V ac ± 10%, 47.5 - 63 Hz, 3 wire, single phase
dc, self-contained power supplies	+ 5 V dc ± 5%, regulated +15 V dc ± 5%, regulated -15 V dc ± 5%, regulated
Consumption	150 watts
Frequency Range	
Baseband Relay	300 Hz to 10 MHz
IF Relay	60 MHz to 80 MHz
VSWR	
Baseband Relay	< 1.1 over baseband frequency range
IF Relay	< 1.15 over IF frequency range
Impedance	75 ohms, unbalanced
Insertion Loss	0.2 dB for the "normal through" path and the loopback path
Crosstalk and Isolation	
Baseband Relay	> 95 dB crosstalk between the transmit & receive "normal through" paths >60 dB isolation for the normal transmit & receive signal paths during loopback operations

TABLE 4-11. MAU OPTIONS LEADING PARTICULARS (CONT.)

<u>SWITCHING/LOOPBACK GROUP</u> (Cont.)	
Crosstalk and Isolation (Cont.)	
IF Relay	>65 dB crosstalk between the transmit & receive "normal through" paths
	>50 dB isolation for the normal transmit & receive signal paths during loopback operations
Switch Contacts	hermetically sealed
Relay Voltage	± 15 vdc
Baseband Attenuator	
Frequency Range	300 Hz to 10 MHz
Impedance	75 ohms, unbalanced
Attenuator	16 dB to 46 dB in 2 dB steps
Attenuator Accuracy	± 0.25 dB plus 1 percent of attenuator setting
Power Dissipation	0.25 watt average
<u>NOISE LOADING GROUP</u>	
Dimensions (inches)	
Group/Supergroup Noise Generator	7.00H X 16.625W X 20.75D
Supergroup Switch	7.00H X 16.625W X 20.75D
Supergroup Switch Patch Panel	3.50H X 17.25 W X 16.75D
Group Switch	7.00H X 16.625W X 20.75D
Group Switch Patch Panel	3.50H X 17.25 W X 16.75D
Weight	124 pounds (includes one each of above elements)

TABLE 4-11. MAU OPTIONS LEADING PARTICULARS (CONT.)

NOISE LOADING GROUP (Cont.)

Power	
Primary ac	115 V ac ± 10%, 47.5 - 63 Hz, 3 wire, single phase
dc, self contained power supplies	+ 5 V dc ± 5% +15 V dc ± 5% -15 V dc ± 5%
Consumption	700 watts
Supergroup Signal Interface	
Connections	Christmas tree terminal block
Characteristic Impedance	75 ohms, unbalanced
Frequency Range	312 kHz - 552 kHz (min)
Input VSWR (max)	1.05 except during noise loading, 1.2 during noise loading
Output VSWR (max)	1.05
Isolation	75 dB (min)
Noise Loading Level per Supergroup	+4 dBm (Supergroup Noise Generator at maximum output)
Group Signal Interface	
Connections	Christmas tree terminal block
Characteristic Impedance	135 ohms, balanced
Frequency Range	60 kHz - 108 kHz (min)
Input VSWR (max)	1.05 except during noise loading, 1.2 during noise loading
Output VSWR (max)	1.05
Isolation	75 dB (min)
Noise Loading Level per Group	-20 dBm (Group Noise Generator at maximum output)

TABLE 4-11. MAU OPTIONS LEADING PARTICULARS (CONT.)

NOISE LOADING GROUP (Cont.)	
Noise Generator Outputs	
Group Switches	8 outputs (max) at up to 200 cable feet
Supergroup Switches	8 outputs (max) at up to 200 cable feet
Connectors (All)	Twinax
Noise Loading Group Spectral Density	± 3 dB of nominal from 68 kHz to 100 kHz; greater than 60 dB below nominal for frequencies between 56 kHz to 64 kHz and 104 to 112 kHz; greater than 40 dB below nominal for frequencies below 56 kHz and above 112 kHz
Noise Loading Supergroup	± 3 dB of nominal from 340 kHz to 524 kHz; greater than 60 dB below nominal for frequencies between 280 kHz to 320 kHz and 554 kHz to 584 kHz; greater than 40 dB below 280 kHz and above 584 kHz
Levels	Controllable in 1 dB steps over 30 dB range to -20 dBm (max)
Switching Capacity per Chassis	
Supergroup	Up to 10 supergroups
Group	Up to 25 groups
Patch Panel Impedances	
Supergroup	75 ohms, unbalanced
Group	135 ohms, balanced

TABLE 4-11. MAU OPTIONS LEADING PARTICULARS (CONT.)

<u>IDLE LINE SEIZURE CONTROLLER</u>

Dimensions (inches)	7.00H X 19.00W X 22.00D
Weight	45 pounds
Power	
Primary ac	115 V ac ± 10%, 47.5 - 63 Hz, 3 wire, single phase
dc, self-contained power supplies	+15 V dc ± 5%, regulated -15 V dc ∓ 5%, regulated
Consumption	150 watts
Idle Channel Detection	Full Duplex
Idle Channel Seizure	Full Duplex on Idle Lines
Reinserted SF Signal Level	
Transmitter	-20 dBm0 ± 1 dB with strappable test tone levels of +4, 0, -2, -4 or -15 dBm
Receiver	-20 dBm0 ± 1 dB with strappable test tone levels of +7, +4, 0, -2 or 8 dBm
Reinserted SF Signal Drive Impedance	135 ohms, 600 ohms, or 900 ohms balanced, strappable
Reinserted SF Signal Frequency	2600 Hz ± 0.2 Hz
VF Channel Status Detector Idle Condition	2600 Hz ± 15 Hz tone present on the transmit and receive lines for ≥ 2 seconds at a steady state level of -29 to -11 dBm0
Line Restoration Time	50 milliseconds

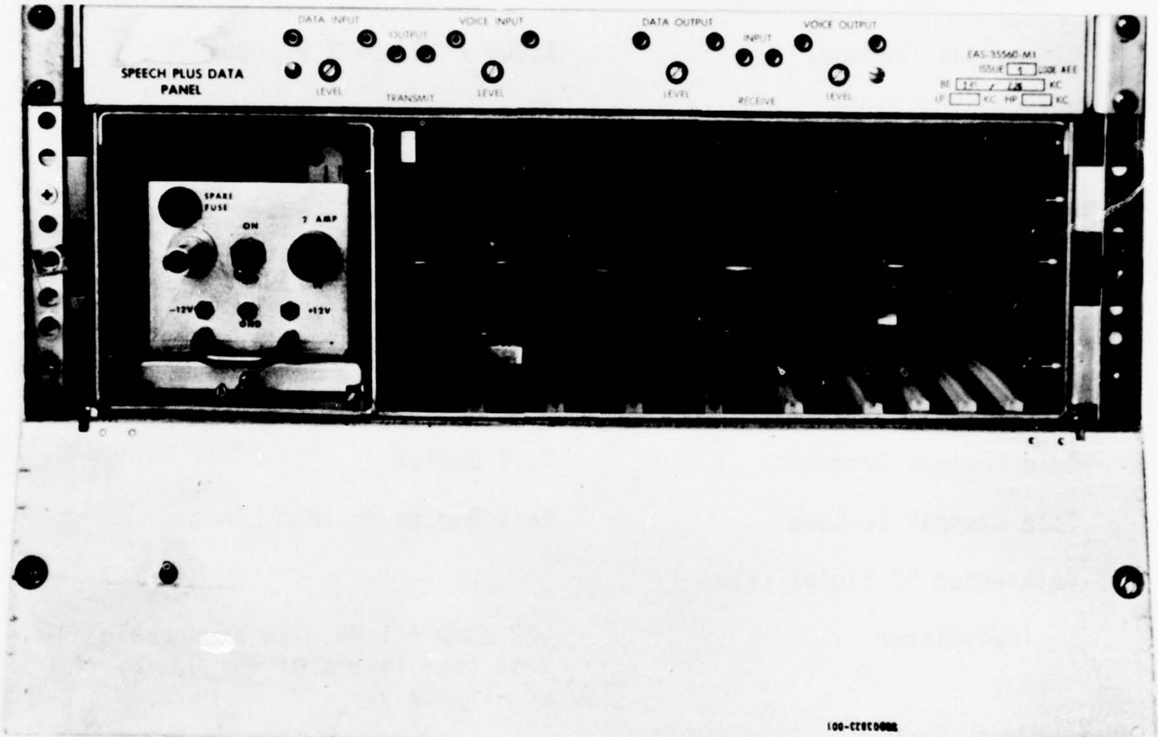


FIGURE 4-46. VOICE DATA COMBINER, FRONT VIEW

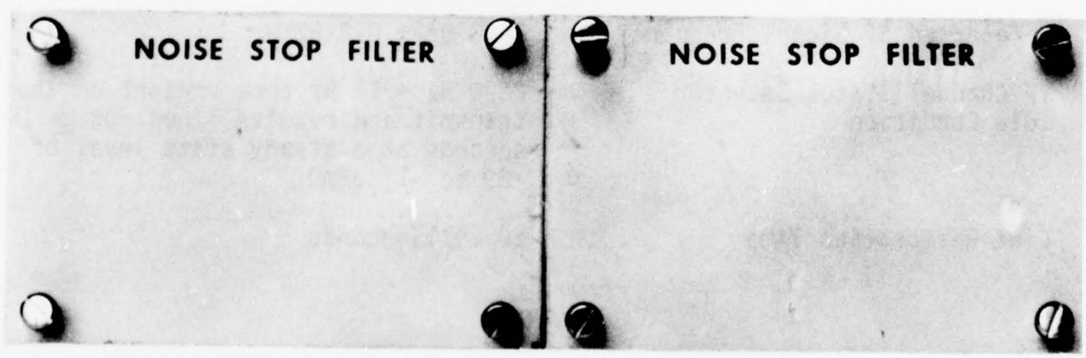


FIGURE 4-47. NOISE STOP FILTERS, FRONT VIEW

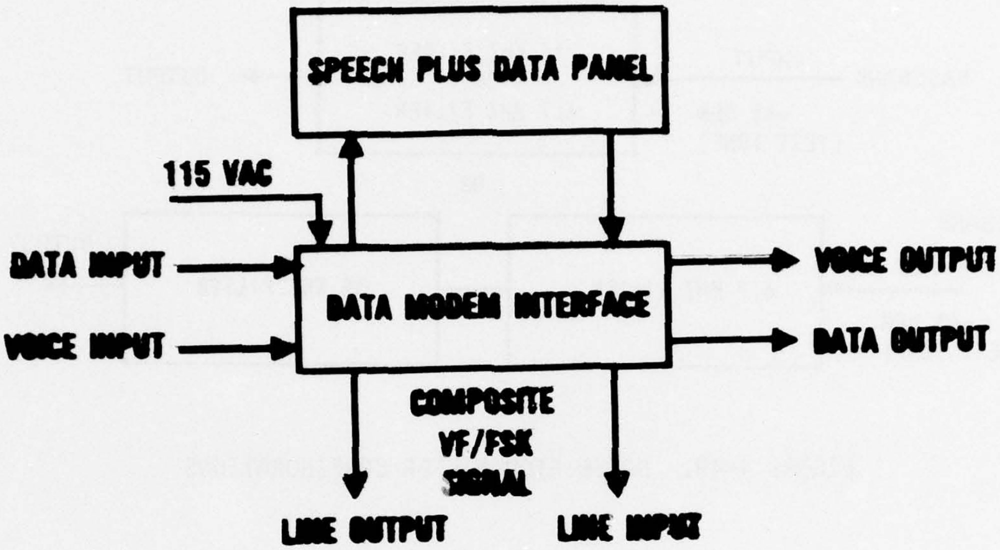


FIGURE 4-48. V/DC BLOCK DIAGRAM

TABLE 4-12. V/DC LEADING PARTICULARS

<u>Dimensions (inches)</u>	
Speech Plus Data Panel	1.75H X 19.375W X 10.00D
Data Modem Interface	5.25H X 19.375W X 17.00D
<u>Weight</u>	40 pounds
<u>Power</u>	
Primary ac	115 V ac $\pm$ 10%, 47.5 - 63 Hz single phase, 3 wire
dc, self-contained power supplies	+12 V dc $\pm$ 5%, regulated -12 V dc $\mp$ 5%, regulated
Consumption	10 watts

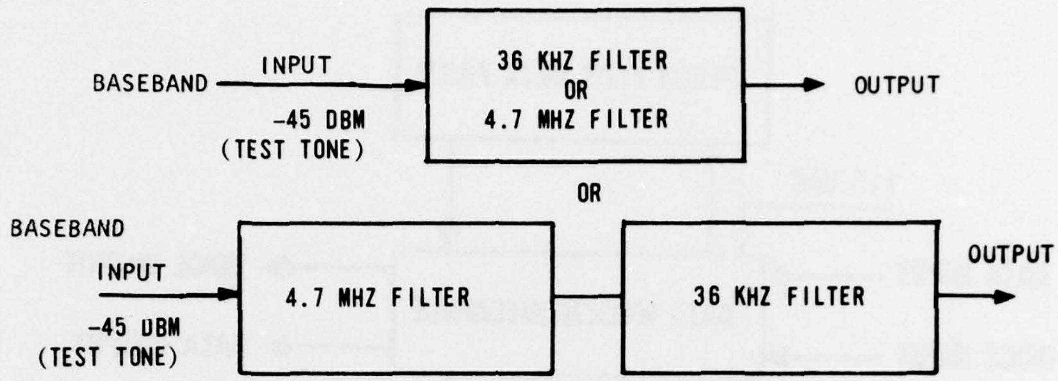


FIGURE 4-49. NOISE STOP FILTER CONFIGURATIONS

TABLE 4-13. NSF LEADING PARTICULARS

Dimensions (inches)	3.50H X 5.60W X 2.25D
Weight	5 pounds
Power	Not required
Stop Band Center Frequency	
Below Multiplex Band	36 kHz
Above Multiplex Band	4.7 MHz
Notch Attenuation	
36 kHz NSF	30 dB minimum at 4.5 kHz bandwidth
4.7 MHz NSF	30 dB minimum at 250 kHz bandwidth
Insertion Loss	0.35 dB max., 300 Hz - 8.5 MHz

TABLE 4-13. NSF LEADING PARTICULARS (CONT.)

Operating Level	Equivalent to Test Tone level of -45 dBm
Impedance (Input/Output)	75 ohms unbalanced
Input/Output Connector	TNC
Noise Power Ratio	75 dB minimum

SECTION 5

CPMAS COMMON DESIGN CHARACTERISTICS

5.1 GENERAL

This section summarizes those design characteristics and requirements of the CPMAS equipments that are not reflected in the individual descriptions of functional performance. The listed characteristics apply to each CPMAS equipment except where specific exceptions are noted.

5.2 TRANSPORTABILITY

The CPMAS equipments were designed to be transported by rail, air, ship and highway carriers.

5.3 STORAGE

a. Serviceable: To be packed with desiccant, wrapped in pliofilm vapor barrier and stored in an upright position in a dry warehouse.

b. Unserviceable: To be stored in an upright position in a dry, enclosed warehouse.

5.4 ENVIRONMENTAL CONDITIONS

5.4.1 Service Conditions.

The CPMAS equipments were designed and constructed to meet the following service conditions.

a. Temperature:

(1) Non-operation, transit, storage: minus 18°C (0°F) to plus 52°C (plus 125°F).

(2) Operation: plus 13°C (plus 55°F) to plus 35°C (plus 95°F).

b. Low Pressure:

(1) Non-operation, transit, storage: sea level to 50,000 ft (3.44 in of Hg).

(2) Operation: sea level to 5,000 ft (24.89 in of Hg).

c. Shock: After encountering shocks during service and handling and during shipment by land, sea, and air.

d. Vibration: After encountering vibrations during operation and shipment by land, sea, and air.

e. Humidity:

(1) Non-operational storage as packaged for shipment: Up to 100 percent relative humidity, including condensation due to temperature changes.

(2) Operational: Up to 80 percent relative humidity without condensation.

f. Fungus: When exposed to heterotrophic plants in warm, humid atmosphere.

5.4.2 Environmental Tests.

Environmental testing was conducted in accordance with Military Standard MIL-STD-810B, "Environmental Test Methods", with exceptions and additions as follows:

a. Low Temperature. Method 502, Procedure I, Step 2, storage temperature minus 18°C (0°F) for not less than 48 hours; Step 4, operating temperature plus 13°C (plus 55°F).

b. High Temperature. Method 501, Procedure II. Step 7, operating temperature plus 35°C (plus 95°F).

c. Shock: Method 516.1. Procedure I, terminal peak sawtooth pulse, 20 g peak value, 11 milliseconds time duration, Figure 516.1-1; equipment non-operating as packaged for transit and Procedure V, except the Disk Drive Unit which was subjected to the following Bench Handling criteria:

Test Item	Drop
Over 40 lbs.	0.5 in. (or minimum of Procedure V, whichever is less)

d. Vibrations: Method 514.1. Procedure X, Curves AW and AY, Notes 1 and 2, equipment non-operating, total land transportation 3,000 miles.

5.5 ELECTROMAGNETIC COMPATIBILITY (EMC) CONTROL

5.5.1 Electromagnetic Interference (EMI) Control Requirements.

The CPMAS equipments were designed to conform to the EMI emission and susceptibility requirements of Military Standard MIL-STD-461A, Notice 3, "Electromagnetic Interference Characteristics; Requirements For Equipment", for Class A3 equipment as listed in Table 5-1.

TABLE 5-1. EMI CONTROL REQUIREMENTS

Test Method	Title	Frequency Range
CE 01	Conducted Emissions Power Line	240 Hz - 20 kHz
CE 02	Conducted Emissions Signal Line	240 Hz - 20 kHz
CE 03	Conducted Emissions Power Line	0.02 - 50 MHz
CE 04	Conducted Emissions Signal Line	0.02 - 50 MHz
RE 02	Radiated Emissions Electric Field	14 kHz - 1 gHz
CS 01	Conducted Susceptibility Power Line	30 Hz - 50 kHz
CS 02	Conducted Susceptibility Power Line	50 kHz - 400 MHz
CS 06	Conducted Susceptibility Power Line	Spike
RS 02	Magnetic Field (Induction) Susceptibility	60 Hz 20 amps, Spike
RS 03	Electric Field (Radiated) Susceptibility	14 kHz - 10 gHz

NOTE: C = Conducted
R = Radiated
E = Emission
S = Susceptibility

5.5.2 EMI Testing.

EMI testing of the CPMAS equipments was performed according to the procedures given in Military Standard MIL-STD-462, Notice 3, "Electromagnetic Interference Characteristics, Measurement of", to verify the requirements listed in Table 5-1. Minor out of limit conditions were observed during Test Methods CE 04 and RE 02 for the PATE, BBSA, ARS, MAU, PM and PATE, BBSA, ARS, MAU, respectively. The PATE, BBSA, PM and BM did not completely meet specified requirements for RS 03 Electric Field Susceptibility (5 volts/meter) at several frequencies. However, these equipments were determined to be completely suitable for the operating environment based on actual electric field radiation measurements taken at overseas ATEC test sites. In all cases the field measurements were less than 0.5 volt/meter and in most cases less than one millivolt/meter.

5.6 RELIABILITY

5.6.1 Mean-Time-Between-Failure (MTBF) Data.

Table 5-2 lists the specified and predicted MTBF figures for the CPMAS equipments.

5.6.2 Reliability Prediction.

A reliability prediction for each CPMAS equipment was performed using "RADC Reliability Notebook", RADC TR-67-108, Vol. II, and Military Handbook MIL-HDBK-217B, "Reliability Prediction of Electronic Equipment".

5.6.3 Reliability Demonstration.

Reliability demonstration testing was performed for the NSS equipments, PATE, ARS, and MAU. This testing consisted of fixed, 250-hour tests of each equipment.

5.7 MAINTAINABILITY

5.7.1 Maintainability Requirement.

A Mean-Corrective-Maintenance-Time ($\overline{M}_{ct}$) no greater than 28 minutes and a Maximum-Corrective-Maintenance Time ($M_{Max_{ct}}$) no greater than 84 minutes (95th percentile) were specified for each CPMAS equipment. A scheduled maintenance (i.e., preventive maintenance) time not to exceed 30 minutes per period was specified for each CPMAS equipment, where the period does not recur more frequently than once for each 168 hours of equipment operation.

TABLE 5-2. MEAN-TIME-BETWEEN-FAILURE (MTBF) DATA

Equipment	Specified MTBF (Hours)	Predicted MTBF (Hours)
Central Processor	190	187
Data Concentrator Set	130	168
Technical Control Console	450	357
PATE Variable No. (Function)		
1 (IQCS)	320	336
2 (I/OQCS)	240	255
3 (DDMS)	330	339
4 (IQCS-MSMS)	290	290
5 (I/OQCS-MSMS)	230	239
6 (IQCS-MSMS-DDMS)	280	286
7 (IQCS-DDMS)	310	324
8 (I/OQCS-DDMS)	240	252
9 (I/OQCS-DDMS-MSMS)	230	237
BBSA	260	293
ARS	425	451
MAU	650	659
A Scanner	3600	3626
A/C Scanner	3600	3659
TSS	1875	1909
PM	5800	7416
BM	2800	3491
V/DC	5000	7416

NOTE: The PATE and MAU MTBFs do not include the scanners.

5.7.2 <u>Maintainability Demonstration</u>.

Maintainability demonstration testing of the NSS equipments, PATE, ARS, and MAU verified the $\overline{M}_{ct}$ and $M_{Max_{ct}}$ specified for these equipments. The demonstration was performed in accordance with the corrective maintenance provisions of Test Method 2 of Military Standard MIL-STD-471, "Maintainability Verification Demonstration/Evaluation", using a consumer's risk of 10 percent.

SECTION 6

REFERENCE DOCUMENTS

6.1 GENERAL

The information in this report was obtained from various military specifications and standards, manuals, and other documents listed below.

6.2 SPECIFICATIONS

The hardware and computer program specifications for the CPMAS equipments are listed in Tables 6-1 and 6-2, respectively.

6.3 MILITARY STANDARDS

a. MIL-STD-188-100, "Common Long Haul and Tactical Communication System Technical Standards," 15 November 1972.

b. MIL-STD-188-310, "Subsystem Design and Engineering Standards for Technical Control Facilities," 2 August 1971.

c. MIL-STD-490, "Specification Practices," 30 October 1968.

d. MIL-STD-810B, "Environmental Test Methods," 15 June 1967, Notice 1 (20 October 1969), Notice 4 (21 September 1970).

e. MIL-STD-461A, "Electromagnetic Interference Characteristics Requirements for Equipment," 1 August 1968, Notice 1 (7 February 1969), Notice 2 (20 March 1969), Notice 3 (1 May 1970).

f. MIL-STD-462, "Electromagnetic Interference Characteristics, Measurement of," 31 July 1967, Notice 1 (1 August 1968), Notice 2 (1 May 1970).

g. MIL-STD-471, "Maintainability/Verification Demonstration/ Evaluation," 15 February 1966, Notice 1 (9 April 1968).

h. MIL-STD-483, "Configuration Management Practices for Systems, Equipment, Munitions, and Computer Programs," 31 December 1970.

6.4 MANUALS

a. Technical Manual, Operation and Maintenance Instructions, Nucleus Subsystem, HA4-1-14N-01, Vol. I & II, April 1976.

b. Technical Manual, Operation and Maintenance Instructions, Test Set, Electronics Systems AN/GYM-13(V) (Programmable ATEC Terminal Element), HD4-2-09P-01, Vols. I, II, & III, 29 June 1976.

TABLE 6-1. CPMAS HARDWARE SPECIFICATIONS

Equipment (Common Name)	Spec. No.	Part I (Type B1)	Part II (Type C1b)
ATEC System	SS75000850B	31 Mar 71	N/A
	SCN	26 Apr 71	
	SCN	17 Jun 71	
	SCN	14 Sep 71	
	SCN	29 Sep 71	
Technical Control Console Set	CP75000851D	8 Jul 74	None
Central Processor Set	CP75000854D	8 Jul 74	None
Data Concentrator Set	CP75000856D	8 Jul 74	None
Baseband Signal Analyzer	CP75000861D	28 Jun 76	14 Dec 76
Programmable ATEC Terminal Element	CP75000873	13 Aug 76	16 Jul 76
ATEC VF/DC Scanners	CP75000874	31 Mar 76	16 Jul 76
Test Signal Source	CP75000875	31 Mar 76	16 Jul 76
Measurement Acquisition Unit	CP75000876	18 May 76	14 Dec 76
Alarm Reporting Subsystem	CP75000877	18 May 76	9 Nov 76
Pilot Monitor	34027288	14 Apr 76	14 Dec 76
Baseband Monitor	34027289	12 Apr 76	14 Dec 76
Voice/Data Combiner	34027294	5 Apr 76	1 Dec 76

NOTES:

1. The format and contents of the listed specifications, except for the System Specification SS75000850B, were prepared in accordance with Military Standard, MIL-STD-490, "Specification Practices".

2. The Part Is are Type B1, Prime Item Development Specifications, which contain the performance, design, development, and test requirements.

3. The Part IIs are Type C1b, Prime Item Product Fabrication Specifications, which contain the requirements for manufacture and acceptance of the item.

TABLE 6-2. CPMAS COMPUTER PROGRAM SPECIFICATIONS

Part I (Type B5) Development Specifications	Spec. No.	Date
Central Processor Software	CP75000855C	21 Jun 73
Data Concentrator Software	CP75000857C	21 Jun 73
PATE Software	CP75000872	Jun 76
Part II (Type C5) Product Specifications		
Central Processor Software	CPCI75000855	
	Vols. I, II & III	12 May 75
	Vols. IV - X	21 Apr 75
Data Concentrator Software	CPCI75000857	2 May 75
PATE Software	CP75000872 (10 Volumes)	Oct 76

NOTES:

1. The format and contents of the specifications listed above were prepared in accordance with Military Standard, MIL-STD-490, "Specification Practices".
2. The Part Is are Type B5, Computer Program Development Specifications, which establish the functional performance requirements.
3. The Part IIs are Type C5, Computer Program Product Specifications, which provide a narrative description of the program operation, detailed flow diagrams and program listings.

c. Operation and Maintenance Handbook for Baseband Signal Analyzer (BBSA), HA4-2-15S-01, May 1975.

d. Operation and Maintenance Handbook for Monitor Telemetering Unit (MTU), HA4-2-15M-01, September 1973.

(1) MTU Addendum No. 1 - Voice Data Combiner, October 1974.

(2) MTU Addendum No. 2 - Noise Stop Filter, October 1974.

(3) MTU Addendum No. 3 - Switching/Loopback Group, October 1974.

(4) MTU Addendum No. 4 - Pilot Monitor, October 1974.

(5) MTU Addendum No. 5 - Idle Line Seizure Controller, October 1974.

(6) MTU Addendum No. 6 - Noise Loading Group, December 1974.

(7) MTU Addendum No. 7 - Baseband Monitor Group, November 1974.

(8) MTU Addendum No. 8 - Reflected Power Sensor, November 1974.

6.5 OTHER PUBLICATIONS

a. "System Description, Automated Quality Monitor Reporting Subsystem," SD-0568, Stelma, Incorporated, May 1968.

b. Feik, R. L., "A Concept for Semi-Automated Technical Control (SATEC) for Communications Facilities," Operations Research Report 5-ORR-67, September 1967.

c. RADC-TR-70-121, Final Technical Report, "Automated Technical Control (ATEC)", Honeywell, Incorporated, August 1970; Vol. I, Part I (AD 874-539); Vol. I, Part II (AD 874-546); Vol. II (AD 874-547).

d. RADC-TR-70-120, Final Technical Report, "Automated Technical Control", Philco-Ford Corporation, July 1970, Vol. I (AD 873-034), Vol. II (AD 873-035).

e. RADC-TR-76-302, Final Technical Report, "ATEC Digital Adaptation Study, FKV Requirements for PA/FI/TA," Honeywell, Incorporated, October 1976; Vol. I (A033538); Vol. II (A033566); Vol. III (A033716).

f. Bell System Technical Reference PUB 41009, "Transmission Parameters Affecting Voiceband Data Transmission Measuring Techniques," January 1972.

g. RADC-TR-67-108, "RADC Reliability Notebook," Vol. II (AD 821-640), September 1967.

h. Military Handbook, "Reliability Prediction of Electronic Equipment," MIL-HDBK-217B, 20 September 1974.

i. DCA Circular 310-70-1, "DCS Technical Control," Defense Communication Agency, Vols. I, II, III, IV, January 1967.

j. "Program of Instruction for Operator Training of the Automated Technical Control System (ATEC)," Air Training Command Course No. 1ASC30750/TVC, Vols. I & II, December 1975.

☆U.S. GOVERNMENT PRINTING OFFICE: 1977-714-025/140

METRIC SYSTEM

BASE UNITS:

Quantity	Unit	SI Symbol	Formula
length	metre	m	...
mass	kilogram	kg	...
time	second	s	...
electric current	ampere	A	...
thermodynamic temperature	kelvin	K	...
amount of substance	mole	mol	...
luminous intensity	candela	cd	...

SUPPLEMENTARY UNITS:

Quantity	Unit	SI Symbol	Formula
plane angle	radian	rad	...
solid angle	steradian	sr	...

DERIVED UNITS:

Quantity	Unit	SI Symbol	Formula
Acceleration	metre per second squared	...	m/s
activity (of a radioactive source)	disintegration per second	...	(disintegration)/s
angular acceleration	radian per second squared	...	rad/s
angular velocity	radian per second	...	rad/s
area	square metre	...	m
density	kilogram per cubic metre	...	kg/m
electric capacitance	farad	F	A·s/V
electrical conductance	siemens	S	A/V
electric field strength	volt per metre	...	V/m
electric inductance	henry	H	V·s/A
electric potential difference	volt	V	W/A
electric resistance	ohm		V/A
electromotive force	volt	V	W/A
energy	joule	J	N·m
entropy	joule per kelvin	...	J/K
force	newton	N	kg·m/s
frequency	hertz	Hz	(cycle)/s
illuminance	lux	lx	lm/m
luminance	candela per square metre	...	cd/m
luminous flux	lumen	lm	cd·sr
magnetic field strength	ampere per metre	...	A/m
magnetic flux	weber	Wb	V·s
magnetic flux density	tesla	T	Wb/m
magnetomotive force	ampere	A	...
power	watt	W	J/s
pressure	pascal	Pa	N/m
quantity of electricity	coulomb	C	A·s
quantity of heat	joule	J	N·m
radiant intensity	watt per steradian	...	W/sr
specific heat	joule per kilogram-kelvin	...	J/kg·K
stress	pascal	Pa	N/m
thermal conductivity	watt per metre-kelvin	...	W/m·K
velocity	metre per second	...	m/s
viscosity, dynamic	pascal-second	...	Pa·s
viscosity, kinematic	square metre per second	...	m/s
voltage	volt	V	W/A
volume	cubic metre	...	m
wavenumber	reciprocal metre	...	(wave)/m
work	joule	J	N·m

SI PREFIXES:

Multiplication Factors	Prefix	SI Symbol
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto*	h
10 = 10^{1}	deka*	da
0.1 = 10^{-1}	deci*	d
0.01 = 10^{-2}	centi*	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

* To be avoided where possible.

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