SYSTEMS
ENGINEERING LABORATORIES

Site Installation Manual

SEL 32

October 1976

• Publication Number 313-325200-000 • Price: $ 25.00

LIST OF EFFECTIVE PAGES

The total number of pages in this manual is 182, consisting of the following:

Page	Issue
Title	Original
A	Original
i through iv	Original
1-1 through 1-4	Original
2-1 through 2-16	Original
3-1 through 3-132	Original
4-1 through 4-12	Original
5-1 through 5-8	Original
6-1 through 6-4	Original

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

LIST OF ILLUSTRATIONS

SECTION I

SYSTEM LAYOUT AND SEL 32 PREINSTALLATION GUIDELINES

SYSTEM LAYOUT

INTRODUCTION

It is the responsibility of the customer to determine a suitable layout for his computer system components prior to delivery. The layout will be affected by considerations such as the specific components included in the system, size and shape of the computer area, location of columns and doors, maximum length of signal cables, and aesthetic appearance. The basic complex of computer cabinets must be treated as a single unit when preparing sample layouts.

The successful installation and operation of a SEL 32 Computer System requires detailed planning and scheduling. The customer must provide suitable space, electrical power, and other equipment such as storage cabinets for magnetic tape. In many cases, the customer will find it advisable to establish a consulting schedule with the SEL Sales Representative to insure that the facilities are ready when the machine is delivered. This section describes the physical requirements, such as floor area and electrical power, for the SEL 32. The methods by which these requirements are met are the responsibility of the customer. The SEL Sales Representative is available at all times for advice and assistance.

TRAFFIC FLOW AND MATERIAL HANDLING

Paper handling and card equipment such as printers, punches, and readers must be easily accessible for efficient operation. Equipment should be laid out to permit sufficient space for passage of carts and personnel. Adequate space and clearance must be provided for waste or takeup containers. Since large amounts of material can be consumed in a short time, it is recommended that storage for paper supplies be located adjacent to the operation area (Refer to illustration in figure 1-1).

Some movable equipment is often serviced in the Customer Service area. Access to this area should be convenient and on the same floor level as the computer area. In the interest of safety, equipment such as magnetic tape transports should not be moved on ramps from one level to another.

VISIBILITY AND OPERATING CHARACTERISTICS

Most efficient operation results when the operator can visually monitor the physical activity of the computing system. Many devices have no moving parts and do not require operator intervention; however, some units utilize lights to indicate various operational conditions. All such units should be arranged so the indicators are visible from the console.

Printers, card punches, and similar devices produce appreciable amounts of waste which may find its way into dust-sensitive mechanisms such as card readers, magnetic tape transports, and disc equipment. Waste-producing devices should, therefore, be placed as far as possible from dust sensitive mechanisms and close to the room air exhaust outlet.

Since the printers and punches are comparatively noisy, they should be located in the area where a moderately high noise level is not objectionable.

CONVENIENCE OUTLETS

The customer should provide accessible convenience outlets within 15 feet of each cabinet in the computer system to enable an oscilloscope cart to be positioned at the logic chassis within each cabinet. The convenience outlets may be in the perimeter walls and/or in raised floor panels. The receptacles should be of the single phase grounded type and should be connected to the building power system. For 60 Hz installations, the nominal voltage should be 115 volts. The receptacles must comply with local electrical codes.

PERIPHERAL EQUIPMENT SIGNAL CABLES

The maximum cable lengths between the peripheral device controller and the external devices are specified for each device in section III.

CUSTOMER SERVICE AREA

For most SEL 32 installations, it will not be necessary to maintain a separate, fully-equipped customer service area. However, if it should become necessary for customer service personnel to repair or service the equipment, he should be given access to an area having at least two 115 Vac grounded receptacles and storage facilities for spare parts.

FINAL CHECKS

Upon completion of the installation, SEL technical personnel will operationally test the equipment to assure error-free operation. during the period, the performance of the air-conditioning system must be checked, and any necessary final adjustments made by the customer's contractor.

PREINSTALLATION GUIDELINES

RECEIVING AND LOCATING OF EQUIPMENT

The customer is expected to provide for all transfer of equipment from the receiving dock to the area of the use inside the customer's facility. Doors, elevators, etc. must have the strength and clearance necessary for moving the individual units of the system to the site. The general rule is that hallways or aisles should be 5 feet (minimum) and doors should be 80 inches high (minimum).

SECURITY

If the customer's facility is subject to security regulations, SEL's representative should be made aware of this at the earliest possible time so that the necessary clearance papers may be processed.

TELEPHONE

Ensure that there is a telephone inside the computer room with 24-hour service.

UNIONS

If there is a union, ensure that all responsibilities are cleary defined and understood so that no infringements of policy take place due to lack of clarification.

SCHEDULING

A successful installation is dependent upon the effective execution of a realistic schedule. This form should list the activities in the order in which they are generally undertaken and the average time normally allocated to each task. Space should be provided to record actual progress with the suggested schedule. As a guide, the schedule may be broken down as follows:

1. Approximately seven months before the delivery of the SEL equipment, the system equipment complement should have been determined, including a realistic allowance for future expansion. All interested personnel having a part in the project should have reviewed this guide for a reasonably complete understanding of the program to be followed. Tentative sites from which the final site will be chosen should have been selected.

2. Six months before the delivery date, a satisfactory layout should have been worked out and preparation of preliminary plans and specifications started.

3. Four months before the delivery date, the site design should be completed in sufficient detail to permit the orderly letting of the site facility contracts. The plans should include provisions for relocation of any equipment and personnel and for clearance of the area of all unneeded obstructions and facilities.

4. At least three months before the delivery, orders should have been placed for the power and air-conditioning equipment and all other purchased items. The final SEL equipment layout must be completed. Any revisions to the layout after this will necessitate recoordination with SEL.

5. One month before delivery, site preparation should be sufficiently complete to permit test operation of facilities.

SCHEDULING (Cont'd)

6. All work, except final adjustments, must have been completed one week before delivery.

SUMMARY

Because the specific details of installation are complex and involve a wide range of technology, it is strongly recommended that only qualified experienced personnel be utilized for planning and designing the installation facilities. This Installation Planning Guide is intended to provide sufficient technical details concerning the SEL equipment to enable these personnel to effectively perform their task. SEL's specialists are available for consultation at any time.

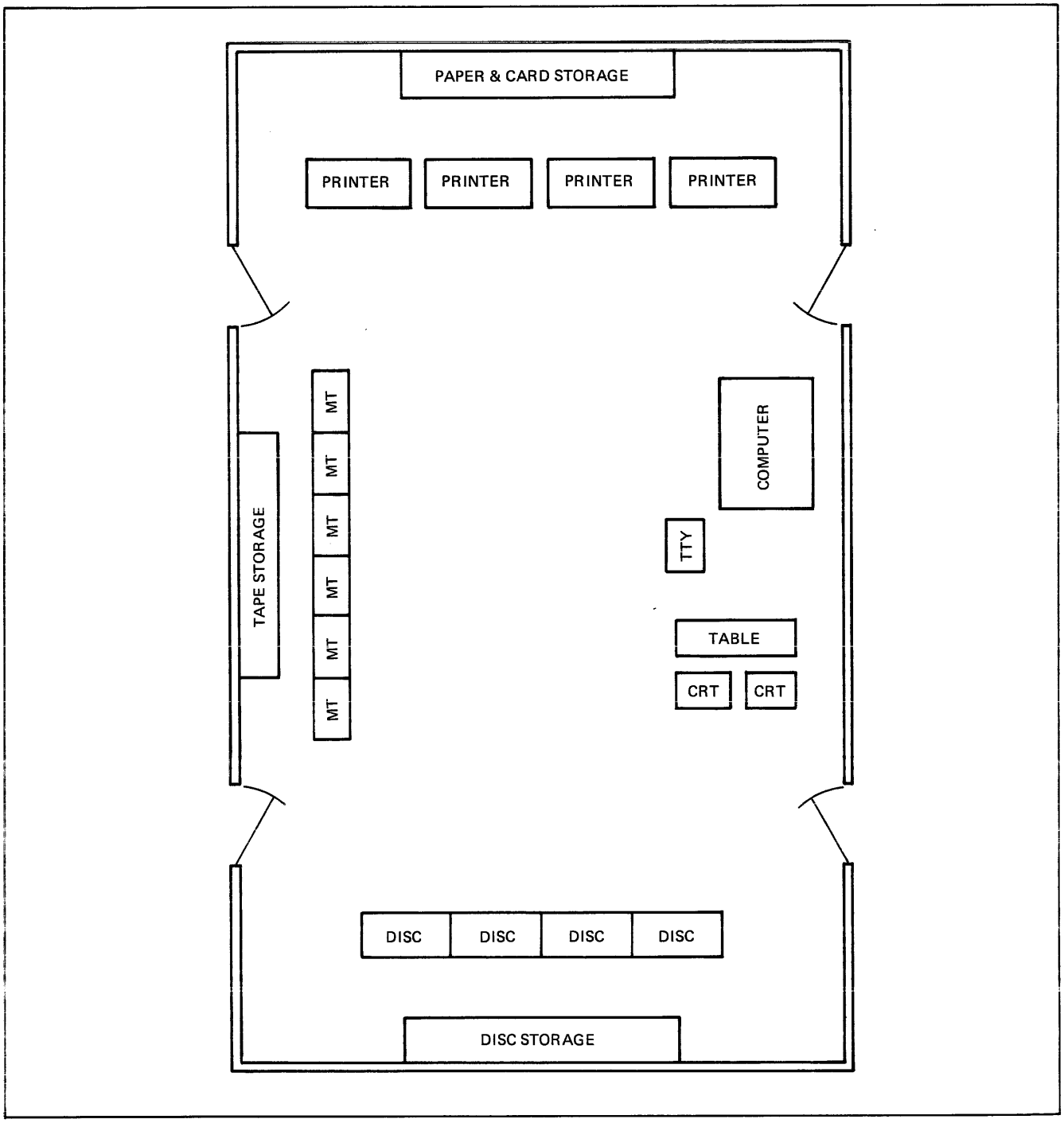


Figure 1-1. System Layout

SECTION II

INSTALLATION GUIDELINES

INTRODUCTION

This Installation Planning Guide provides data to assist in the installation of the SEL 32 Computer Systems.

The successful installation of a data processing system involves various services and/or contractors. Planning the installation must include a preliminary review of the equipment complement and facility requirements as provided by this Guide. For the most efficient site preparation, site design work must be handled by professional engineers and architects, and the construction work must be performed by qualified electrical, mechanical, and structural contractors. The customer must appoint someone qualified to supervise and coordinate this effort.

Although selecting the site and providing the facilities are customer responsibilities, SEL Enginnering Specialists are available for consultation on problems that may be incurred by the customer or his contractors. The building or area chosen to house the computing system should meet the space and convenience requirements of the present equipment layout and provide for future expansion. If a new building is to be constructed, a suitable equipment layout must first be established. This layout (together with the other building requirements) should then be presented to the architect.

The building or area should be selected on the basis of the following basic requirements:

1. Floor loading and type of construction.

2. Air conditioning facilities.

3. Availability of adequate electrical power.

4. External influences, such as radar and transmitters.

5. Adequate protection from hazards such as fire, smoke, water, lighting, and radiation.

6. Space with proper environment to house the processing system and associated equipment.

7. Site security (vandals etc.)

8. Ceiling height, outside wall and glass area.

9. Flow of work to and from other areas.

10. Expansion of the system.

11. Adequate building entries to receive packaged equipment. Minimum dimensions of building entry required to receive crated equipment are as follows:

    Width 60 Inches Height 80 Inches

    Access to the entry requires 6 feet of clearance ahead when being approached from a right angle in a corridor or foyer using roll-a-lifts.

12. Spare parts storage and maintenance area.

ENVIRONMENT

TEMPERATURE AND HUMIDITY

The temperature and humidity requirements of all equipments in the SEL 32 system are listed in section IV. The customer is responsible for examining these requirements and ensuring that the environment of his proposed installation area meets the requirements of all devices in his system.

The SEL 32 is designed to operate with a minimum of environmental restrictions, and can be installed in areas ranging from a computer room or center to the control area for an industrial process. In general, the computer can operate in any environment suitable for human occupancy as long as moisture condensation does not occur. However, for maximum reliability and longest component life, operating temperatures should be held in the range of 70^{o} to 80^{o}F, particularly at higher altitudes.

VIBRATION

The equipment in the SEL 32 system will withstand sustained vibration of up to 0.25 G, where G is gravitational acceleration. The number N of G's of acceleration may be calculated from the following formula:

$$N = 0.103\ A\ F^2$$

where F is frequency in cycles per second.

and, A is amplitude of vibration, measured as displacement in inches from the mean.

If metric units are used, the above formula becomes:

$$N = 0.262\ A\ F^2$$

where A is measured in centimeters.

ILLUMINATION

An average to 50 to 75 foot-candles (538 to 807 lux) of total illumination measured at 30 inches above the floor should be maintained in the computing area. For better visibility of lighted indicators, brilliant illumination should be avoided. Direct sunlight is not recommended.

The area directly over the CRT displays should be on a separate circuit in case it is necessary to use dimmers. Fluorescent dimmers are available if the proper transformers, ballasts, etc. are used. The lights will have full brightness during normal use. Controls can handle up to 1000W. (Fluorescent dimming is not generally recommended, but incandescents would look out of place and annoying if the remainder of the lighting is fluorescent.)

ACOUSTICS

The principal sources of noise in the installation are electromechanical devices such as printers and card punches. These devices should be in an where a relatively high noise level is not objectionable. Although not essential for system operation, the user may consider it desirable to acoustically treat the computing area. For best results, an acoustical consultant should be engaged; however, the following general points should be observed. Floors and walls should be constructed of a properly sealed material which will not transmit vibrations to other areas. Echoes and reverberating effects may be diminished by treating walls and doors with an absorbent material. In most instances, the greatest reduction in noise level can be obtained by acoustical treatment of the ceiling. It is ususally convenient to do this, and acoustic ceiling tile enhances the appearance of the computing area.

SEL makes the following recommendations for the construction of the rooms which will house the computer system.

Ceiling - Owens/Corning fiberglass acoustical board, 1 inch thick, nubby. The material is available in 2 ft. x 4 ft. panels and is suspended in a convential manner. This is a white fiberglass finished material and should not be painted.

ACOUSTICS (Cont'd)

Walls - Owens/Corning fiberglass acoustical board, 1-inch thick, unpainted linear. For wall applications, this material is available in 4 ft. x 8 ft. sheets. It should not be painted. It has an attractive texture, and the color is pale yellow.

ALTITUDE

Maximum altitude specifications for each SEL product are provided in section IV.

AREA CLEANLINESS

The principal function of the air filters in the computing system cabinets is to capture dust which may be circulating in the room atmosphere. The equipment air filters in the computing system cabinets should be cleaned approximately once a week. The filters in the air conditioning units should be cleaned on a similar schecule.

When an underfloor plenum system is used to cool the computer cabinets, some dust may originate beneath the raised floor. This dust is produced chiefly by deterioration effects of the normal room floor and can be held to a minimum if the floor is properly conditioned. In particular, the floor should be sealed and treated to prevent dusting.

All paper-handling equipment is subject to varying amounts of static charge which attracts dust particles and tobacco ash. Static buildup on magnetic tape handlers will attract small particles. For this reason, smoking should not be permitted in the computer area.

Area Maintenance

After computer system installation, a regular cleaning schedule should be started. The exact frequency and degree of cleaning will depend on conditions in the area. Listed below are some of the items which must be included in the cleaning schedule with the recommended minimum frequency of their occurrence.

Item	Minimum Occurrence
Damp Mopping (Tiled Areas)	Weekly
Vacuuming of Carpeted Areas	Weekly
Wash Windows (Inside)	Monthly
Vacuum Under Raised Floor	Twice Yearly
Vacuum Air Supply Ducts	Yearly
Clean Room Air Diffusers	Twice Yearly
Clean Light Fixtures	Twice Yearly
Clean Walls	Yearly
Clean Ceiling Tiles	Yearly

Waxed Tile

As a paste wax causes build-up and dust, it is not recommended. A high pressure laminate covering requires no waxing, and an occasional damp mopping is all that is generally required. In no case should wax on vinyl coverings be allowed to exceed three layers.

AIR CONDITIONING

Normally, the SEL 32 computer and peripherals do not require additional air conditioning to provide sustained high performance. However, the heat they generate must be added into whatever heat level is being currently handled.

AIR CONDITIONING (Cont'd)

Keep in mind that a person generates 300-400 Btu/hr. Therefore, the number of people normally expected in the room should be considered as well as any additional equipment. Windows and lights also can have a significant affect on capacity requirements.

Specific power dissipation is in section III, Computer and Peripheral Specifications.

To calculate the approximate number of tons of additional air conditioning required by a system, divide the total system Btu/hr by the number 12,000. Conversion from watts to Btu/hr is also shown.

Btu/hr = Watts x 3.41

$$\text{Approximate Tons} = \frac{\text{Btu/hr}}{12{,}000}$$

For efficient equipment cooling, a minimum clearance of 30 inches above the equipment cabinets is recommended. If this requirement cannot be met, other means of allowing free air flow above and around the equipment must be devised. Insulation of ceilings and walls will increase air conditioning efficiency and result in reduced operating costs. Metal walls and partitions are not recommended unless they are insulated on the conditioned surface. All windows and doors should be made weather tight, and the use of slow-operating door closers should be avoided. Double glass is recommended for insulating large glass areas.

Because some pieces of equipment generate more heat than others, therefore requiring more cooling air, an efficient means of distributing and balancing the air system is required.

Note

Floor cabling cutouts under the equipment must not be used to supply cooling air to the equipment.

It is important that a well-designed, separate air conditioning system be used for year-round operation in the computer area, and that heat loads due to future expansion be considered in the design. The air conditioning system should contain sufficient capacity to provide proper cooling during maximum seasonal conditions with provisions for adequate back-up air conditioning considered.

Air entering or being recirculated through the air conditioning system should be filtered. Two types of filters are as follows:

- Electrostatic Plate Type Filter - This type must be rated as a minimum of 85-90% efficient by the National Bureau of Standards discoloration test using atmospheric dust.
- Mechanical Filter - 20% minimum filtration efficiency based on the National Bureau of Standards blackness of discoloration test using atmospheric dust.

Filters selected for use should be permanent, easily washable, and meet UL and fire code standards. (Refer to NFPA 90A.) Other considerations should include high efficiency at low pressure drop, trouble-free operation, culimination of downstream dirt during replacement, minimum maintenance, simple installation, and provision of particle-free air at minimum cost.

Special air filtration is necessary only where installations are exposed to corrosive gases, salt air, or unusual dirt or dust conditions. If these conditions exist, an air filtration specialist should be consulted.

AIR CONDITIONING (Cont'd)

A recording instrument should be provided to keep a continuous record of temperature and humidity conditions in the area. The recorder should be located where iw will record continuously the average conditions within the area. Alarms should be provided to indicate if the environmental limits are exceeded.

The environment for the most efficient EDP system operation and personal comfort is 73°F ±5% relative humidity, measured at the 5-foot level. The design of the air conditioning system should be based on this environmental condition and include consideration to meet this goal. However, the Systems may be operated within the following environmetal ranges:

65°F - 80°F
35% - 60% Relative Humidity

Ambient air entering the process equipment should be within these limits, with the temperature rate of change not exceeding 1°F per four minutes.

The extreme operating environmental design limits of the equipments are greater than the limits specified above. However, sustained periods of operation beyond the recommended limits are neither desirable nor compatible with the environment required for magnetic tape, paper tape, and punch cards as outlined in Information Media Storage.

Note

The recommended operating environment as stated above was derived from a combination of USASI, EIA, and I/O media manufacturer specifications, tempered with past experience. Few systems, if any, can attain the desired degree of reliability and efficiency when operated at their extreme environmental limits. Under no circumstances should the dew-point be reached in the data processing room.

INFORMATION MEDIA STORAGE

In determining the layout of the computing system, the user should consider the requirements for storing magnetic tapes, disc packs, paper tape, and punched cards. Tape reels should be stored vertically in steel bins; disc packs should be stored horizontally (never vertically) in steel cabinets.

The reels of tape and disc packs should be stored in self-cleaning cases for protection from dust and sharp environmental changes.

Magnetic Tape

Magnetic Tape used in data processing is generally a high quality Polyester best suited for computer application. Such tape, although of high quality, is sensitive to changes of temperature and relative humidity. Extreme changes of either temperature or, most importantly, relative humidity can cause the tape to alter in dimension and characteristic, making it unsuitable for use. Magnetic Tapes should be stored in their cases while not in use to protect them from damage, dust, and humidity changes. Empty cases should not be left open; dust will contaminate the case and eventually the tape. Always carry reels by their hub and avoid bodily contact with the tape, because body oils can cause contamination. Do not carry reels by the outer flange rims, because this tends to damage the reel and the tape.

Air conditioning should be provided to the tape storage area to ensure an adequate tape environment. Environmental limits should be within the environmental specifications given in the following paragraphs.

Stored tapes should be at least 3 inches away from walls not air conditioned on the far side. This will prevent them from being affected by moisture and thermal transmission through walls. Under no circumstances should tapes be exposed to magnetic fields, because they influence data stored on tapes.

When tapes are removed from their conditioned environment they must be environmentally reconditioned before use. The recondition time must be equal to the length of time the tape was removed, but not more than 24 hours. Magnetic tapes stored at temperatures below 40°F and above 110°F (90°F for recorded tape) may be permanently damaged and, therefore, should not be stored outside this environmental range.

Magnetic Tape (Cont'd)

Note

Magnetic tape used with SEL equipment leased from and/or maintained by SEL shall meet SEL specifications or equivalent.

Extremes in temperature and humidity should be avoided. Recommended conditions are 35% to 60% relative humidity and 62°F to 78°F (16.7°C to 25.5°C). If environmental extremes occur, the tape should be brought to ambient conditions before use. The time required for reconditioning will vary from 4 to 16 hours, depending upon the conditions to which it was subjected. Direct heat such as lamps or heating coils should never be used to warm a tape. Errors will occur less frequently if the tape storage area is the same temperature and humidity as the computing area.

The tape should be rewound once or twice each year to release stress due to expansion and/or contraction.

CAUTION

Tape should not come in contact with any magnetic material, and reels should not be stored in cabinets having magnetic latches. Any magnetic field intensity greater than 70 gauss may cause loss of data.

Magnetic Disc Pack

Disc packs are affected by temperature and humidity as is magnetic tape and, therefore, require the same environment and handling as magnetic tape.

Storage - Disc Packs (recorded or unrecorded) may be stored for up to five years (maximum) in areas where the temperature range of -40°F to 150°F (-40°C to 65.5°C) and a relative humidity range of 8% to 80% are maintained if a wet bulb reading never exceeds 85°F (29.4°C).

Operation - Disc Packs should be operated in ambient environmental conditions not exceeding 60°F to 120°F (16.6°C to 48.4°C) and 8% to 80% relative humidity with a wet bulb reading never to exceed 78°F (25.5°C). The disc pack should be conditioned in the ambient environment for a minimum of two hours before use.

CAUTION

In either case (storage or operational), recorded packs should never be exposed to any stray magnetic field intensity exceeding 50 gauss.

Paper Tape

The physical dimensions and characteristics of paper tape are affected by temperature and, most importantly, by humidity. Paper tape usually performs well when its environment is stable and the tape is conditioned to the use-equipment environment. Abrupt humidity changes should be avoided. Paper tape should be stored in the same environment as magnetic tape. Long-term tape storage should be within the environmental limits as indicated for cards below.

Cards

Punched cards are affected by temperature and humidity as are paper tape, paper documents, and printer forms. Environmental changes will affect the cards size and weight and may cause warping. This is a frequent source of card trouble in data processing equipment. A stable environment is, therefore, necessary to avoid any changes in the card's dimensions and physical characteristics. Punched cards usually perform well when their environment is stable and they are properly conditioned. Extreme changes of relative humidity below 35% or above 60% may permanently distort cards. Direct access from the storage area to the work area should be provided to prevent abrupt environmental changes. When new cards are received, or used cards are stored outside the environmental limits, a period of acclimation is required. The period of acclimation required is dependent upon the difference of relative humidity between the machine room and the cards. Other factors determining the acclimation period are packaging, air circulation around cards, and the period of

Cards (Cont'd)

time cards were subjected to outside environmental limits. The following table may be used as a guide in determining the approximate time required to acclimate cards packaged in containers open to the machine environment. (Also, see "Long-Term Storage".)

Difference In Relative Humidity	Minimum Time Required for Acclimation
±10%	1 Day
±20%	10 Days
±30% or More	15 Days

Card Storage environment should be within the environmental limits of its respective use equipment as given in the Air Conditioning Planning of this Section.

New Card Use. New cards removed from their cartons should be lightly fanned to eliminate any tendency of the cards to cling together and to release possible static charges. Used cards should never be manipulated unnecessarily and should always be kept under pressure by a card weight either when being used or stored.

Long-Term Storage. The recommended temperature/humidity range for long-term card storage is 65°F to 75°F and 30% to 65% relative humidity. Sudden changes in temperature or relative humidity should be avoided. The card storage area should always be maintained within the above environmental limits. The environmental controls should not be turned off during non-work periods. If the environment in the storage area should fail, and the area has experienced an extended humidity excursion above 75% relative humidity or extended temperature excursion above 100°F at a relative humidity of more than 50%, then the cards have probably receive a severe environmental shock and steps should be taken immediately to prevent permanent damage of the cards. First, restore the environmental control as quickly as possible. The card carton should then be opened, and the inner card boxes removed to tables or desks with their covers slightly raised to help remove excess moisture, which causes expansion buckle in the cards. A reconditioning period equal to one-half the original high temperature humidity exposure period is recommended for cards originally in cartons or boxes. Loose cards should be placed in trays and pressure blocked for a reconditioning period at least twice the original exposure period or as indicated in the above table, whichever is larger.

FLOOR SPACE REQUIREMENTS

Floor Space requirements differ for each system and should include the necessary equipment maintenance area, tape and paper storage area, and provisions for future expansion possibilities. The same environmental conditions should be maintained for all areas, including the magnetic tape and paper storage areas. If the storage area is not under the same environment as the process system, time must be allowed to acclimate the stored material to the equipment environment. Whether an existing area is to be modified, or a new facility is contemplated, several possible equipment layouts should be made to arrive at the optimum. Care must be exercised in planning the equipment layout to avoid exceeding the maximum cable lengths.

A maintenance service area will be required for storage of space parts, test equipment, etc., adjacent to the equipment or readily accessible to it. This area will vary with the size of the system. The maintenance service area should be sized so that for 100 square feet of computer occupied floor area, 8 square feet of maintenance space is provided. In no case should the maintenance area be smaller than 100 square feet. At least two 120 volt, 15 ampere receptacles should be located in this service area.

RAISED FLOOR

If a new area is constructed, it is advantageous to install the computer room floor 6 to 12 inches lower than the normal building floor, eliminating the need for ramps. Raised floors which fulfill the requirements will generally have the following characteristics:

- Elevation of 6 to 12 inches above the normal floor.
- Square flooring panels no larger than 2 feet by 2 feet.
- Panels constructed of metal or metal-clad wood.
- Panels covered by floor covering such as vinyl or vinyl-asbestos tile.
- SEL recommends the stringer or grid system type of raised floor.

All cables enter cabinets through an area at or under the base. A raised floor enables relatively unrestricted routing of cables beneath it and also eliminates the problem of covering the exposed wires and cables that would otherwise lay on the floor. In addition, a suitably constructed raised floor permits equipment layouts to be changed more readily and enhances the appearance of the computer area.

Power wiring beneath the floor is best routed in ducts, raceways, or other approved devices. Most raised floors are not watertight; if an open or non-waterproof raceway is used beneath them, wet mopping of the floor may result in a serious shock hazard to cleaning personnel. It is therefore recommended that suitable precautions be taken to protect all underfloor wiring. If this is not possible, a waterless cleaner should be used on the floor, although cleaners of this type have been found to produce a certain amount of dust. Typical raised floors are shown in figure 2-1 and 2-2.

FLOOR LEVELING

The floor should be level within 1/16 inch per 5 feet, and within 1/8 inch over any continuous length of cabinets joinced end-to-end.

FLOOR LOADING

In calculating floor loading, the following points should be considered:

- In calculating normal room floor loading, 10 pounds per square foot must be allowed for the raised floor.
- The floor must withstand a concentrated load of 300 pounds per square inch over an area of 3 square inches.

The weight of each cabinet is listed in the equipment specifications. If castered equipment is to be installed on a raised floor, the customer should obtain caster cups from his raised floor manufacturer to distribute the load and to stabilize the equipment.

FLOOR PROTECTION

During installation of heavy equipment, the floor must be protected from concentrated loads to prevent damage to the surface. The customer should furnish a temporary protective surface when the computer cabinets are rolled in.

FIRE PROTECTION

SEL assumes no liability for damage by any fire control or prevention system. Fire protection in the computer room should be predicated on the following facts:

- The hardware in a computer system presents no fire hazard, since all items are made of non-combustible or flame retardant materials.
- The system is sensitive to heat and smoke damage, particularly those components with magnetic recording surfaces.
- The system is extremely sensitive to water damage if power is on. However, damage is reduced to virtually none if power is turned off.
- Computer input/output media are combustible. Materials such as line printer paper are stored in large quantities and present a severe hazard.

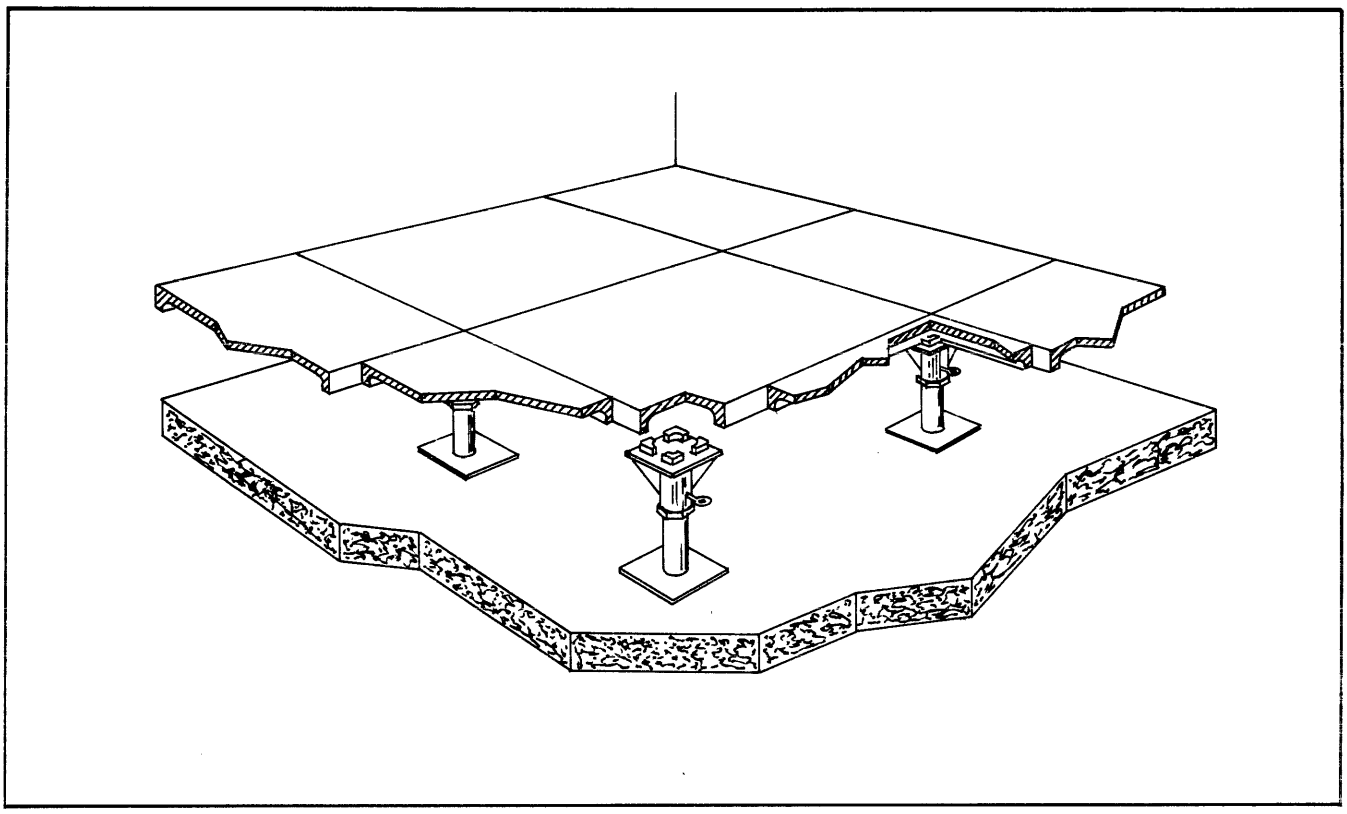


Figure 2-1. Raised Flooring - Pedestal Type

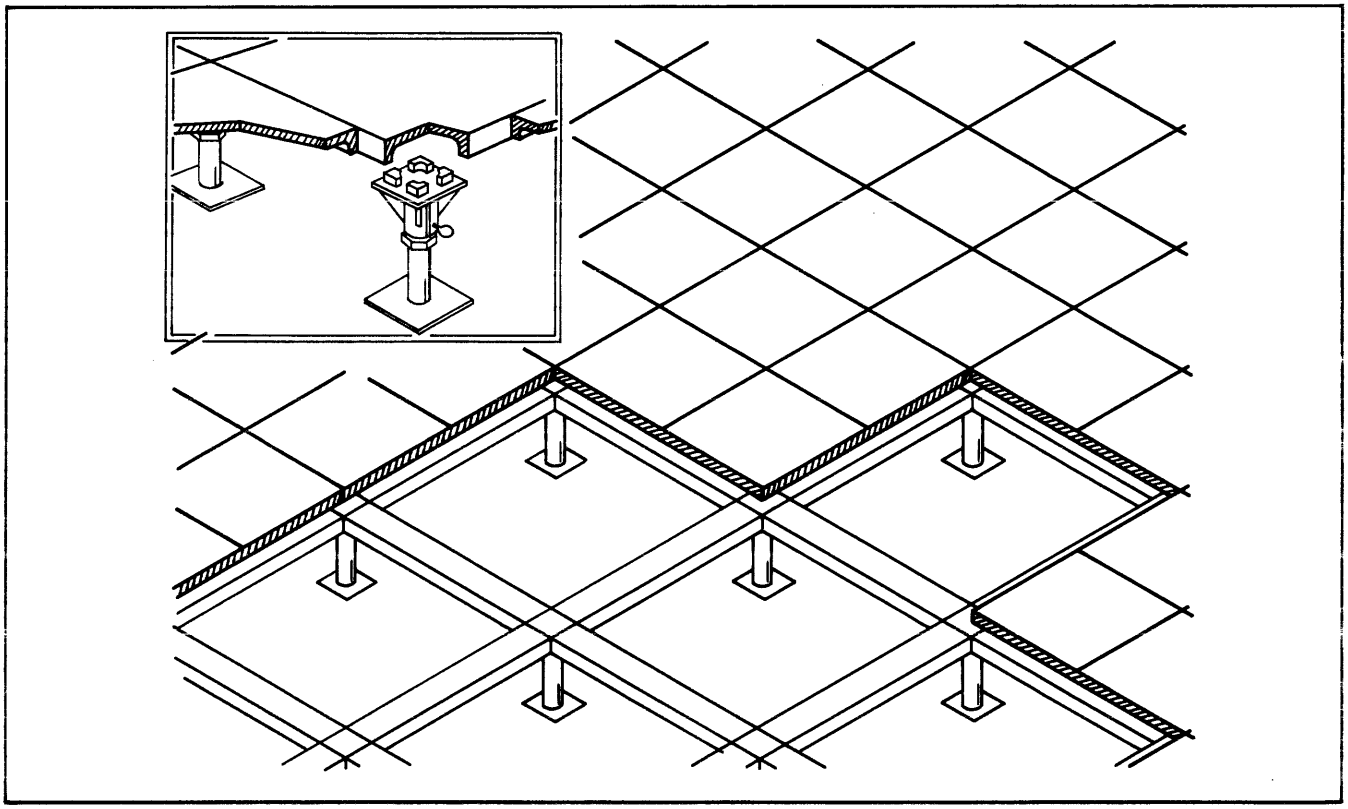


Figure 2-2. Raised Flooring - Grid System Type

FIRE PROTECTION (Cont'd)

- Most computer rooms are air conditioned, posing the hazard of transmitting a fire from an unrelated area to the computer room.

In most cases, local codes establish the protection required for computer systems. This information is generally outlined in the applicable building and electrical codes. Additional information can be obtained from the National Fire Protection Association in Boston, Massachusetts. This organization issues a standard for the protection of electronic computer systems, NFPA No. 75, which should be used as a guide. The computer power must be tied in with a detection system to assure power shutdown prior to application of water to prevent a shock hazard and avoid electrical damage to the computer where sprinkler systems are used.

Underwriters Laboratories listed 15 pound carbon dioxide fire extinguishers to be used in the computer room and to be spaced to cover an area not exceeding 2,500 square feet.

To cover paper type fires, at least one Underwriters Laboratories listed pressurized water type fire extinguisher should be located in the computer room (Prominently marked to indicate that the extinguisher is supplied for paper fire control).

If there is a severe concentration of cable and wire beneath the raised floor and in the dropped ceiling, then either a carbon dioxide extinguishing system or a Halon-1301 fluoride extinguishing system should be considered. These systems will have the capability of smothering and/or controlling and containing a fire until the local Fire Department arrives. Of course, these systems must be a double shot in case the first system falters. Soda acid, foam, and dry chemical type fire extinguishers are hazardous to computer equipment.

A UL-approved fire detection and alarm system should be installed in the equipment area and connected to an approved central station, supervisory system, or to a location in the building under constant attendance.

Smoke detection should be located both above and below the raised floor, providing constant fire supervision during unoccupied periods.

The air conditioning systems for the computer room should also be equipped with a smoke detector system, and should be capable of being used as a smoke and heat removal media if a conflagration occurs.

SEL recommends a preaction type sprinkler system which disconnects the air-conditioning and power and is connected to both smoke and temperature sensors. In the preaction type sprinkler system, no water is in the system until it is activated. On activation, the system should turn off all power to the computer system. The air conditioning should be turned off to prevent transmission of smoke through the building.

Computer input/output media should be stored in a separate room from the computer, since a fire there could be contained and not affect computer operations. Conversely, the room should be fire resistant to prevent damage to valuable records. (See National Fire Protection Association Standard 232.)

The customer should review the computer room's relationship to the remainder of the facility to ensure that fire is not transmitted into the computer room. If the possibility exists, appropriate fire doors should be installed. The possibility of water from other sprinklers running into the computer room through ceilings or walls should be examined.

FIRE PROTECTION (Cont'd)

In systems that are critical to the customer's operation, consideration should be given to standby electrical power and/or divorcing the computer room's environmental and electrical system from the remainder of his facility.

SEL does not recommend the use of carbon dioxide in the computer cabinets. The release of cold gas onto hot electronics would cause severe damage.

The computer room should be constructed of nonflammable or flame retardant material. Materials such as ceiling tiles or flooring should have a flamespread rating of 25 or less. (See National Fire Protection Association Standard 255.) Filters in air-conditioning systems should not smoke excessively if subjected to excessive heat.

The customer should check local fire protection codes to ensure that there are no conflicts in his planned system.

SYSTEM POWER CONSIDERATION

INTRODUCTION

Computer equipment requires a high performance power source with minimum voltage and frequency disturbance. Line voltage disturbances greater than ±10% from nominal and of a greater than 1/2 cycle duration occurring in the source supply are undesirable. Disturbances of the power source are caused by over-loading transformers and feeders and fluctuating power from the public utility. Other disturbances of equal importance may be due to power factor correction by the utilities, lightning, starting of motors, and similar disturbances due to switching large loads of power. If such conditions exist, line buffering may be necessary. Line buffering can be accomplished through the use of motor generator sets or static inverter units. However, an installation planning specialist should be requested to assist the customer in selecting the appropriate device.

A separate transformer should be provided for the data processing system and be fed from the highest primary voltage source available. When this is not possible, it is required that the power provided for the EDP equipment be free of heavy variable loads, such as elevator motors and air conditioning motors. A check of the electrical service should be made prior to equipment installation to assure that power levels are within specified limits and free of objectional fluctuations. The electrical service should be checked for a period of time consistent with the expected system operation time throughout the week. Test equipment used to monitor the electrical service must be adequate, having sufficient response and display so that objectionable short-duration disturbances will be detected. The connection of EAM equipment, such as tabulators, adding machines, and key punches, to the same source as the computer is to be avoided.

The electrical system must be provided in accordance with applicable national and local codes and ordinances.

Convenience outlets shall be provided at various locations throughout the installation area for use by operating and maintenance personnel. As a safety precaution (but not as an operating procedure), a remote power-off device must be provided in the data processing room which can remove all power to the computer system (as per NFPA 75).

SEL 32 Series Computers in domestic applications require a primary power input of 115/230 Vac ±10%, 60 Hz -2 Hz, +3 Hz, 4 wire, 3 pole, single phase. European input power requirement is 230 Vac ±10%, 50 Hz -2 Hz, +3 Hz, 3 wire, 2 pole, single phase. The ac power is distributed by the Model 2195 AC Distribution Panel. (See AC Distribution Panel specification in section III.)

Future expansion through addition of equipment and enlargement of the computer area dictate additional power and air conditioning requirements. Consideration should be given to this possibility when the initial site is planned to ensure the most efficient and economical site expansion.

AC POWER CONSIDERATION

The installation of a process monitor and control computer system typically requires that it be in close proximity to the process.

Many process facilities utilize large amounts of power and contain equipment that generates a wide range of voltage and frequencies. Switching of equipment on and off the power bus and utilization of high power SCR regulators are quite common.

The SEL 32 computer and its peripherals have been designed to provide protection against adverse operating conditions.

Excessive power fluctuations and noise transients can, however, cause problems within the central processor and the peripherals, as well as the data links between the units.

Some examples would be short-duration outages (milliseconds in duration), high-voltage spikes due to inductive load switching, lightning striking the power line, or switching to alternate power sources.

Careful consideration in the planning phase of your facility and the following of proper power generating and distribution practices should alleviate these problems.

Requirements

The general power requirements for the central processor and each of the peripherals is given in section III.

Voltage levels, operating ranges, and frequency variation limits are individually specified.

After completion of your system configuration, a tabular listing should be compiled, including any future expansion units. From this tabulation, an appropriate power generating and distribution system may be planned.

Noise Rejection

Each unit of equipment is individually filtered to reject unwanted noise. However, it may be necessary to add line conditioning to meet the specifications of section III on individual units. A small investment, relative to the system cost, that can have a significant effect on system operation is the use of isolation transformers for power.

Electrically isolating the computer system from the other plant equipment to the greatest possible degree so that unnecessary noise will not be introduced is a highly desirable feature. Isolation transformers, with shielded primary and secondary windings, are specifically intended for this purpose.

Distribution

A circuit breaker panel should be provided for distribution of ac power and ground to the cabinet and devices.

The sizes of the conductors carrying power from the distribution panel to the cabinets and devices will vary according to the loads and the local code requirements where the system will be installed.

The receptacle required for each unit is specified in section III of this manual.

The power wiring should be routed as far as possible from signal carrying cables.

From the distribution panel, four power wires (including a neutral) must be provided to equipments that will receive power. In addition, these equipments must receive an insulated ground wire of at least the same size as the power feeder. The ground and neutral wires must be connected at the transformer secondary or building ground (one point only). Power conductors including the ground wire should be run as a group. The neutral must remain isolated from building ground at all other points. Specific electrical requirements are listed for each equipment in the Specifications Section of this Guide.

Shielding

It is advisable to shield all power conductors connected to the computer system. Power wiring should be run through a metallic conduit that serves as a shield against electrical interference. The conduit should be grounded at the customer-supplied ac distribution panel and insulated at the Central Processor or other device cabinet to avoid creation of a ground loop.

AUXILIARY POWER

The earlier discussion of power requirements assumed adequate line stability for system operation. Elimination of low-energy noise with RF filtering techniques will not compensate for high-energy transients.

In the case where the ac source cannot meet the requirements for electrical noise and harmonic distortion, some type of buffer must be utilized.

TRANSIENT BUFFERS

Transient Buffers are placed between the facility power bus and the computer system. The major types most used are the static inverter or motor-generator with a large flywheel.

The static inverter stores energy in batteries and capacitors and uses this power during fluctuations of the facility power bus.

The flywheel of the motor-generator stores mechanical energy which it converts back to electrical during major transients in the facility bus.

BACK-UP POWER

Where power is frequently out and the computer system must be kept on line, a back-up power system may be warranted. The motor-generator or static inverter may again be utilized but capacity of power storage must be greatly increased as they are now acting as relatively long-term sources.

GROUNDING

The equipment grounding system must serve two major purposes.

Equipment

The safety of personnel must be insured while a steady ground reference for the computer system is maintained.

Local and national codes for safety of electrical equipment can achieve a safe system of grounding, but ground reference stability is determined by how the system grounding is implemented within the safety requirement restraints. Computer system equipment power supplies having a common dc reference are tied to single point in the central processor. Some SEL equipment is isolated by transformer coupled serial link data and can be brought back to a point ground within the general area designated as the computer system reference ground.

In cases where common dc reference supplies are in separate cabinets, they must be isolated from chassis ground to prevent ground loops.

Ground loops are defined as multiple low-impedance paths between circuit commons and the stable ground reference. In instances where excessive noise is coupled into the circuitry by the connection of the dc supply common to the chassis they may be disconnected and brought to Instrumentation Ground. It still remains that the cabinet chassis of the equipment must be adequately grounded to ensure personnel safety and to enable the cabinet to act as a shield for the internal circuitry. Additionally, care must be taken to provide a low impedance ground path for the cabinet's ac line filters. Cabinet ground connections are accomplished by connecting all cabinets in the system to the computer mainframe, using 1-inch braided ground wire. The mainframe furnishes the ground connection for the cabinet ground network.

Instrument

The Instrument Ground System defined as the customer supplied ground system for referencing the computer system and instrumentation must be of high quality. It should be free of high-energy noise transients -- regardless of how infrequently they occur, and provide a low impedance path to earth. When Instrumentation Ground is used as a reference for computer system logic common, the impedance from cabinet chassis to Instrumentation Ground must be maintained within 5 ohms. If for some reason this cannot be met, a special connection direct to the chassis from the point where dc common ties to the instrumentation ground rod must be made. A separate insulated cable of sufficient size (4 AWG or larger) to handle fault currents is recommended.

Earth Connection

The actual earth connection is a vital point in the grounding scheme. A detailed test can be made of soil resistance, conductivity, soil composition, and moisture content to determine the variables such as ground rod diameter, and ground rod depth into the soil. A detailed analysis of these tests and procedures are beyond the scope of this manual, but the general nature of the installation is described below.

The resistance between the facility grounding system and the actual earth ground must be less than 5 ohms.

A copper rod of greater than one-half inch diameter should be driven ten feet or more into the soil. A larger diameter or longer rod must be used if the 5 ohm limitation is not met.

To insure adequate conductivity, treatment of the soil is usually required. Chemicals as common salt, magnesium sulphate, etc., should be added to the soil within a three foot diameter circle around the rod and to a depth of two feet. Soil moisture must be maintained by watering and the soil monitored chemically due to solubility of the chemicals. Periodic ground impedance measurements should be made to ensure that a low-impedance ground has been maintained.

RECOMMENDED GROUNDING SYSTEMS

It is the customer's responsibility to provide a grounding system for all equipment in the system. The grounding system must conform to local electrical codes and meet the requirements outlined in this section.

Safety

The computer system must be grounded for the reasons of safety protection and interference. To protect personnel from electrical shock and to protect equipment from damage in the event of electrical distribution system faults. The safety ground is accomplished by connecting all cabinets and chassis in the system to the computer mainframe using the 1-inch braided wire. The actual grounding of the cabinet ground network is accomplished in the computer mainframe.

Interference

Electromagnetic Control (EMC) involves the control of Radio Frequency (RF) currents to reduce interference between the equipments in the system and between the surrounding environment and the system.

An effective computer grounding scheme may require both a protective ground system and an EMC (or RF) ground system.

Protective Ground System

All computer system cabinets, switch boxes, air conditioners, and other electrical devices in the computer system must be ultimately connected to earth. Usually the protective ground at the building power service entrance is a satisfactory connection point.

The equipment-to-earth conductor can be metallic electrical conduit or the ground wire (usually green) in a power cable. Under no circumstances shall the neutral (white) wire and the ground (green) wire be electrically connected, except at the building service entrance.

Electromagnetic Control Grounding System

The EMC ground system consists of an artificial earth reference plane formed by a conducting grid. Special bonding straps connect each equipment to the grid. This grounding system, unlike the protective ground, is effective at radio frequencies and is used to control RF interference.

The grid is usually constructed from heavy copper or aluminum wire, although at some installations, the metal supporting structure under the raised floor forms a satisfactory grid.

When used, all data processing equipment in the computer installation must be connected to both the grid and the protective ground. Other electrical equipment, such as air conditioners, are connected only to the protective ground.

The EMC ground system outlined is adequate for most computer installations. However, some situations require additional or different EMC measures and must be investigated individually. Some of these situations are:

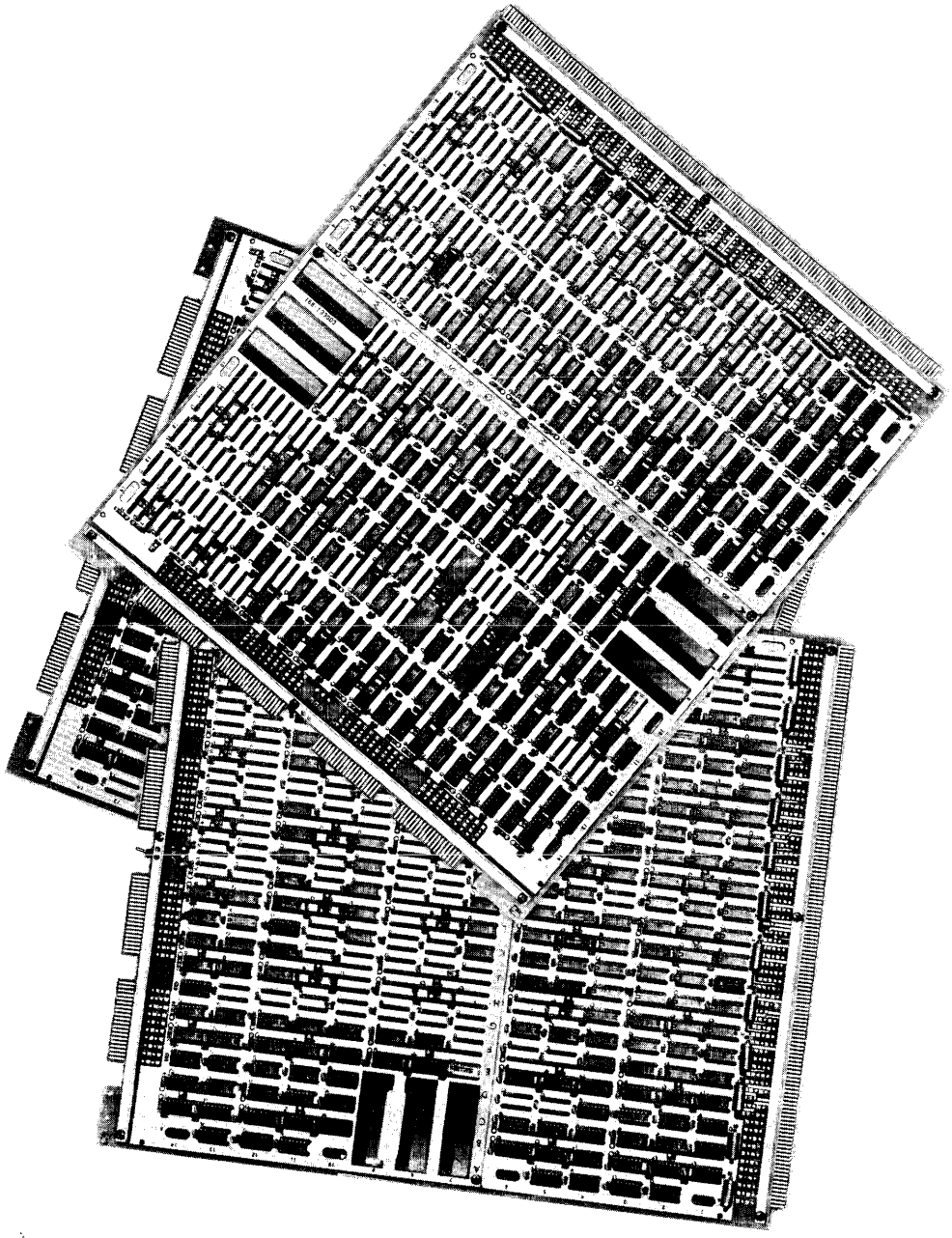
- Installations where analog or low-signal-level equipment is used.
- Installations where remote display or communications equipment is used.
- Installations in areas where high RF radiation levels exist.

SECTION III

SEL 32 COMPUTER AND PERIPHERAL SPECIFICATIONS

INTRODUCTION

This section of the manual describes the SEL 32 equipment specifications in ascending model number order. Table 3-1 provides the SEL 32 physical and environmental specifications.



Central Processor Unit Model 200X

CENTRAL PROCESSOR UNIT MODEL 2000

DESCRIPTION

The Model 2000 Central Processor Unit consists of a 3-board plug-in module, included in all SEL 32/5X Computers. Two of the three boards make up the Micro Arithmetic Logic Unit (MALU). The third board is the Micro Control Unit (MCU) and is referred to as the personality board.

HIGHLIGHTS

- Full 32-Bit Word Format
- Direct Memory Addressing to any Bit, Byte, Halfword, Word or Doubleword in Memory
- Halfword (16-Bit) and Word (32-Bit) Instructions
- Instruction Look Ahead
- Powerful Instruction Repertoire - 152 Instructions
- Bit Manipulation
- Firmware Floating-Point Arithmetic
- Multi-Level Indirect Addressing, plus Pre and Post Indexing
- Eight 32-Bit General Purpose Registers, Three of which can be used for Indexing
- Standard Off-the-Shelf LSI/MSI Components
- CPU on Three Boards - with all Firmware on One Board

SPECIFICATIONS

Prerequisites

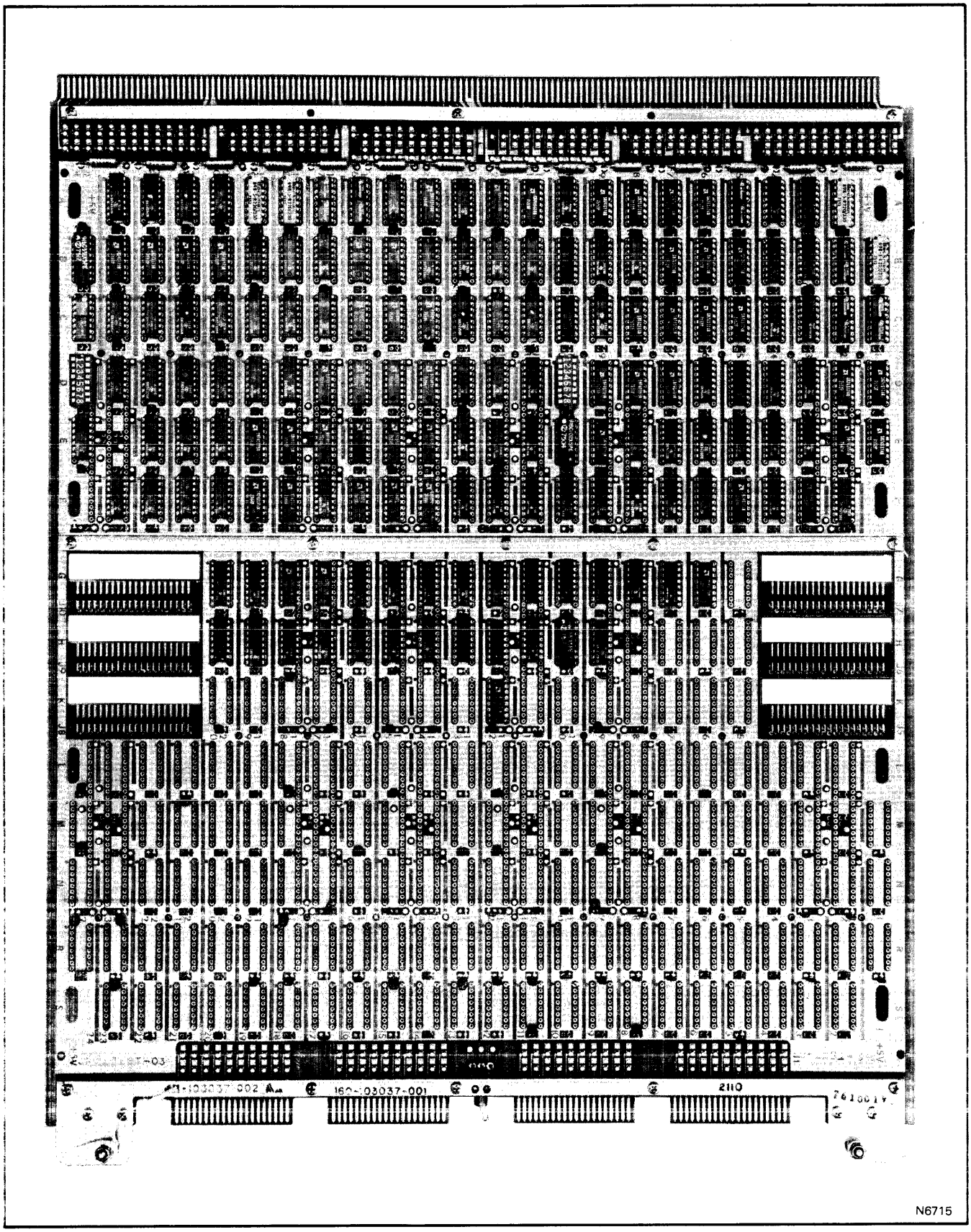
The Model 2000 CPU is included in all SEL 32/5X Computers.

References

Reference Manual SEL 32 - 324-322000
Technical Manual SEL 32 - 303-322000

Physical/ Environmental

Number of Boards	3
Dimensions	15 in. x 18 in. (each plug-in board)
Weight	9 lb
SEL Bus Slots Requirements	6 slots
Power Requirements	Provided by CPU Chassis in Standard Configuration
Environmental	
Operating Temperature	$10^{o}C$ - $40^{o}C$
Relative Humidity	5% - 95% (non-condensing)



Real-Time Option Modules Model 211X

REAL-TIME OPTION MODULE MODELS 2110/2112

DESCRIPTION

Each Model 2110 and 2112 Real-Time Option Module (RTOM) is on a single plug-in module and provides 16 priority interrupt levels and a real-time clock for the SEL 32 Series Computers. Each RTOM will accept one Model 2116 32-Bit Programmable Interval Timer.

The Model 2110, provides the ten basic system interrupts and traps as well as the six highest external interrupts. This module is included as part of the configurations for all SEL 32/5X Computers.

The basic interrupts and traps, which comprise the system integrity features, include power fail, system override, memory parity, arithmetic exception, attention interrupt, non-present memory, undefined instruction, privilege violation, call monitor and real-time clock. In systems that use the Real-Time Monitor (RTM) software, three of the six highest external interrupts are used by the software.

The Model 2112 is an option that may be added to any SEL 32 Series Computer to provide additional external interrupts, or real-time clocks. Since the SEL 32 Series Computers can handle a maximum of 128 priority levels, which include both I/O and external interrupts, the maximum number of RTOM's that can be included in a system is dependent on the number of Input/Output Microprogrammable Processors (IOM) in the system.

Each of the 16 interrupt levels on the RTOM can be individually enabled, disabled, activated, deactivated, or requested under program control.

The real-time clock, which can be connected to any of the 16 interrupt levels on the RTOM, operates from a 60 Hz reference and produces interrupts at intervals of 1/60 or 1/120 second.

The optional Model 2116 interval timer, which has a 32-bit countdown register, can be loaded under program control and decremented at any of several selected rates. These rates include the 300 and 600 nanosecond clocks; the 1.2, 2.4, 4.8, 9.6, 19.2 and 38.4 microsecond clocks; the real-time clock (1/120 sec); or an external clock. When the interval timer's countdown register is decremented to zero, an interrupt is generated.

Any of the 16 external interrupts may be requested by presenting the appropriate external input with a logic ZERO pulse whose duration is 0.2 microseconds minimum, 10 microseconds maximum. Actual interrupt of the CPU program will procede according to the priority polling and interrupt state control for that level. The quiescent (non-requesting) state of the external inputs must be a logic ONE.

HIGHLIGHTS

- 16 Interrupt Levels
- Real-Time Clock

SPECIFICATIONS

Prerequisites

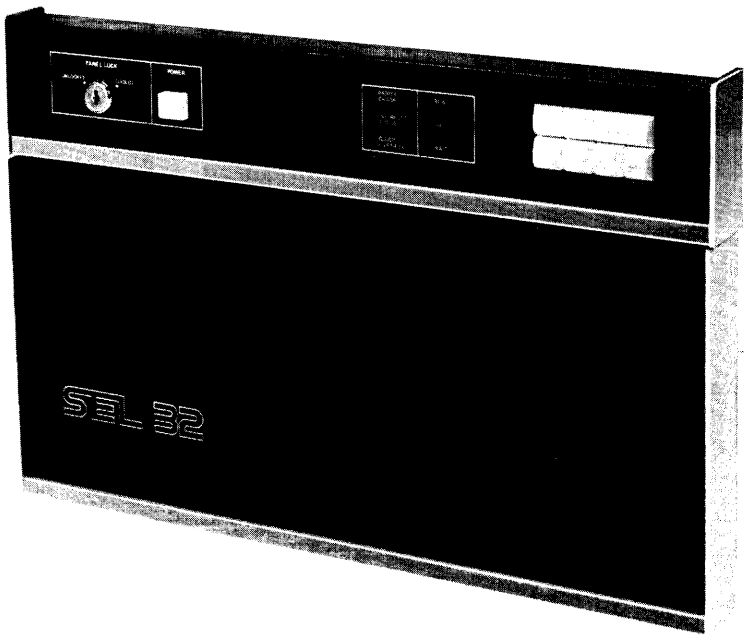
Model 2110 requires a SEL 32/50 Computer

Model 2112 requires a SEL 32/50 or SEL 32/55 Computer

References

Reference Manual 324-322000
Technical Manual 303-322110

Physical/ Environmental	Dimensions	15 in. x 18 in. (plug-in board)
	Weight	3 lb
	SEL Bus Slot Requirements	2 slots
	Power Requirements	Provided by CPU Chassis
	Environmental	Same as CPU
Performance	RTOM Models 2110 and 2112	
	EXTERNAL INTERRUPTS (Models 2110 and 2112)	
	Number of Lines	16
	Logic Level Input	ZERO = +0.8 volts ONE = +2.4 volts
	REAL-TIME CLOCK (Models 2110 and 2112)	
	Reference	60 Hz
	Outputs	1/60 sec 1/120 sec
	INTERVAL TIMER (Model 2116)	
	Countdown Register	32 bits
	Rates	300 nsec 600 nsec 1.2 µsec 2.4 µsec 4.8 µsec 9.6 µsec 19.2 µsec 38.4 µsec 1/120 sec Ext. Signal



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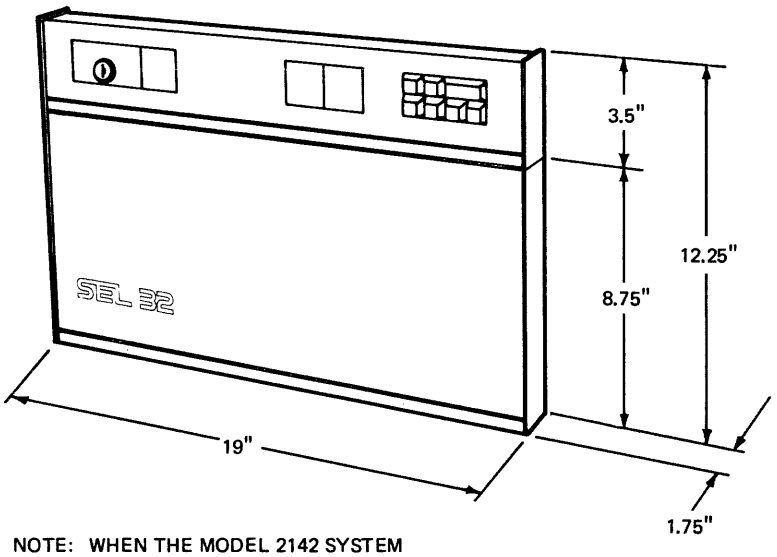


NOTE: WHEN THE MODEL 2142 SYSTEM CONTROL PANEL IS INCLUDED, THE 8.75" BLANK PANEL IS NOT PROVIDED.

Turnkey Panel Model 2140

TURNKEY PANEL MODEL 2140

DESCRIPTION

The Model 2140 Turnkey Panel provides the basic operator controls and indicators for the SEL 32 Series Computers and is included in all systems. Featured on the panel is a key-lock switch to provide system security against unauthorized control of the system. The Turnkey Panel also provides the Power on/off switch for the SEL 32 Series Computers.

The functional controls of the Turnkey Panel include: Run/Halt, System Reset, Attention, Initial Program Load (Bootstrap), and Clock Override. The key-lock switch has two positions for enabling or disabling of the Turnkey Panel function keys. The key-lock switch also applies to the optional System Control Panel when it is included in the system. When the key is turned to locked, the key may be removed, and all function keys are disabled except for the Attention Key and the System Control Panel logic associated with loading and reading control switches.

Light Emitting Diodes are used for status indicators. These include: Parity Error, Interrupt Active, Wait, Run, Halt, and Clock Override.

The Model 2142 System Control Panel, which provides additional controls and indicators, is available as an option.

HIGHLIGHTS

- Key-Lock Switch
- Basic Controls
- Basic Indicators

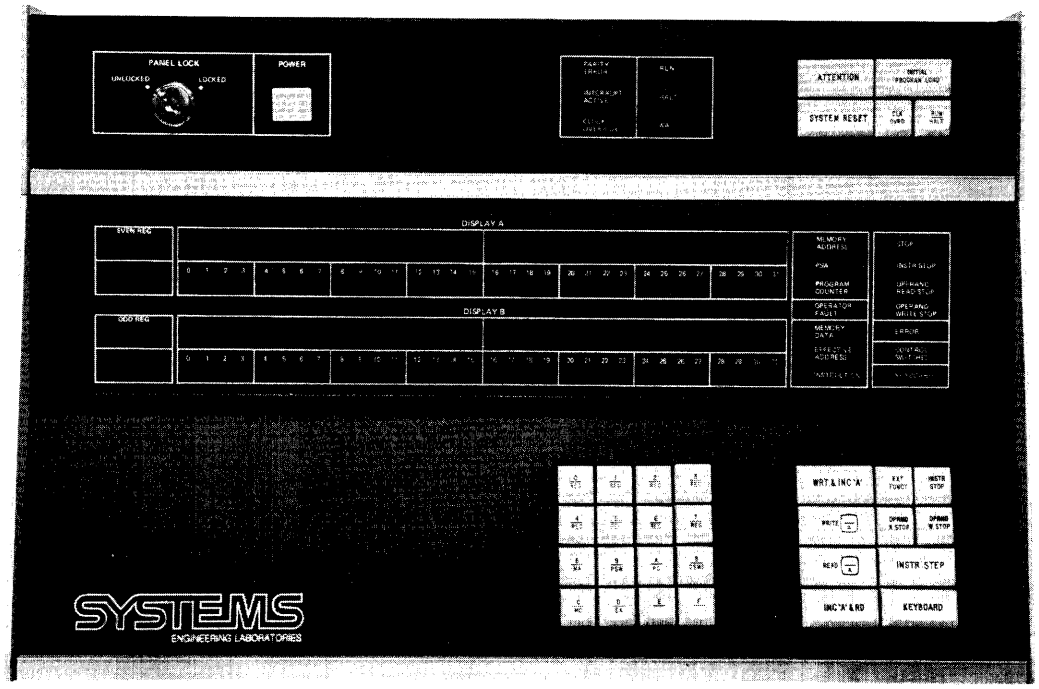
SPECIFICATIONS

Prerequisites N/A

References
Technical Manual 303-322140
Technical Manual 303-322110

Physical/ Environmental

Height	12.25 in.
Width	19.0 in.
Depth	1.75 in.
Weight	7 lb
Mounting	SEL 32 Equipment Cabinet Door (Models 2197 or 2198) or Chassis (Models 2180 or 2181)
Power Requirements	Provided by CPU
Environmental	Same as CPU



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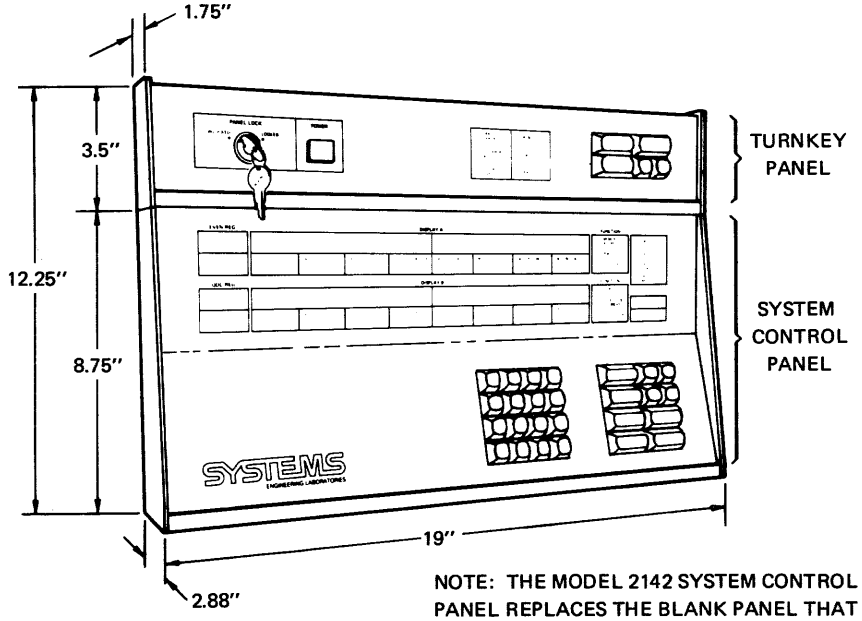


NOTE: THE MODEL 2142 SYSTEM CONTROL PANEL REPLACES THE BLANK PANEL THAT IS PROVIDED AS PART OF THE TURNKEY PANEL.

System Control Panel/Hex Display Models 2142/2145

SYSTEM CONTROL PANEL MODEL 2142 AND HEX DISPLAY MODEL 2145

DESCRIPTION

The optional Model 2142 System Control Panel provides a complete set of operator controls and indicators for the SEL 32 Series Computers. Featured on the System Control Panel are two keyboards and LED's for binary register displays. The optional Model 2145 Hex Display can be added to the System Control Panel to augment the binary displays.

The keyboards are mounted on a sloped panel for operator convenience. When the System Control Panel is mounted on the CPU cabinet door, it is at the optimum height for use from a seated position.

All operator controls on the System Control Panel are on two keyboards. The right-hand keyboard, which provides the function keys, includes the following: Instruction Step, Write, Read, Increment Display A and Read, Instruction Stop, Operand Read Stop, Operand Write Stop, Reset Stops, Keyboard (enable), and Effective Real Address.

The left-hand keyboard is a dual purpose keyboard. It may be used for hexadecimal data entry, or for register select and additional functions. The Register Select and additional functions are enabled when either the Read key or the Write key is depressed.

The displays on the System Control Panel include two 32-bit (eight Hex digits optional) displays, and two 4-bit (one Hex digit) register number displays.

In addition, the following 1-bit indicators are provided: Memory Address, PSW, Program Counter, Memory Data, Instruction, Keyboard, Control Switches, Instruction Stop, Operand Read Stop and Operand Write Stop.

The Model 2142 System Control Panel is interfaced to the SEL Bus through an Input/Output Microprogrammable Processor (IOM) in the same manner as a peripheral device controller. All keyboard entries and displays are handled under firmware control in the CPU.

HIGHLIGHTS

- Full Operator Controls and Indicators
- Hex Entry Keyboard
- Binary Display
- Optional Hex Display

SPECIFICATIONS

Prerequisites

Model 2142 System Control Panel requires a SEL 32 Computer with a Turnkey Panel.

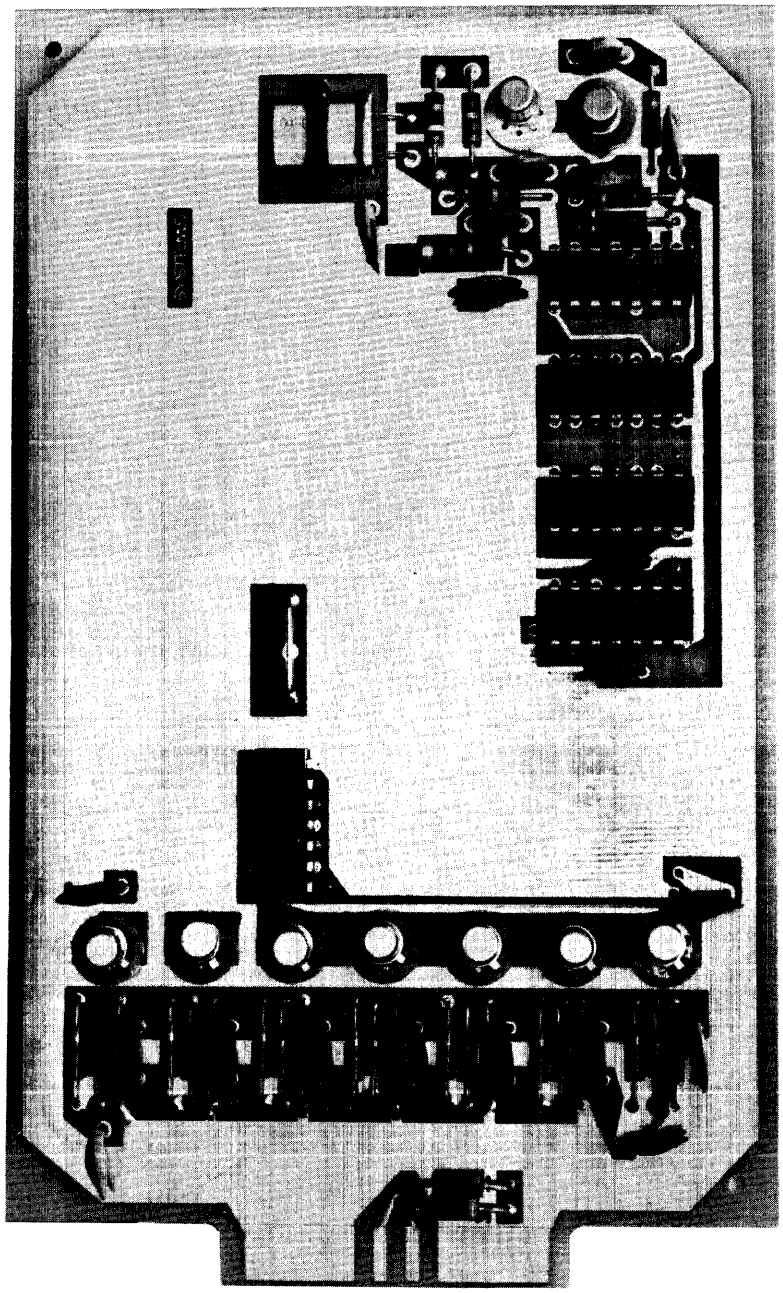
Model 2145 Hex Display requires a Model 2142 System Control Panel.

References

Technical Manual 325-322142

Physical/ Environmental

Height	12.25 in.
Width	19.00 in.
Depth	2.88 in.
Weight	10 lb (includes controller)
Mounting	Panel mounts on front door of CPU Cabinet, and controller plugs into SEL Bus
SEL Bus Slots Requirements	2 slots
Power Requirements	Provided by CPU Chassis
Temp/Humidity	Same as CPU



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Multiprocessor Option Model 2148

MULTIPROCESSOR OPTION MODEL 2148

DESCRIPTION

The Model 2148 Multiprocessor Option is a central timing unit that provides central timing clocks for: special applications, CPU synchronization in multiple processor operations, and shared memory applications. The Multiprocessor Option is on a single plug-in module which is mounted in the AC Distribution Panel, Model 2195.

The Model 2148 Multiprocessor Option can be configured to control two CPU's in one cabinet, or two CPU's in separate cabinets.

The Model 2148-1 Multiprocessor Option is configured to control three CPU's: two CPU's in one cabinet and the third CPU in a second cabinet.

HIGHLIGHTS

- 20 MHz clock for Special Applications
- 13.3 MHz Clock for CPU synchronization in Multiple Processor Applications
- 6.66 MHz Out of Phase Clocks for Shared Memory Configurations

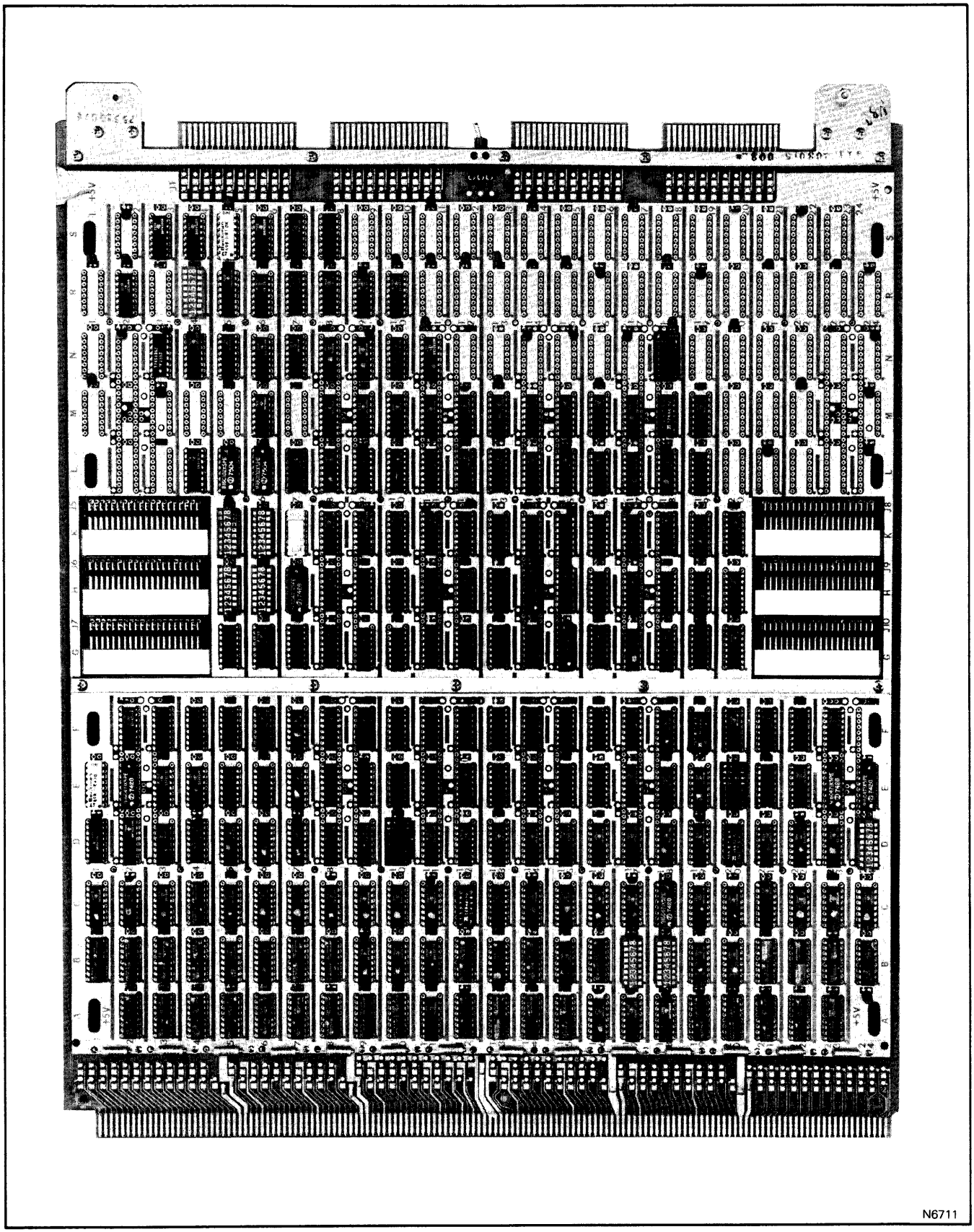
SPECIFICATIONS

Prerequisites: Model 2195 AC Distribution Panel

References: Technical Manual 303-322000

Physical/ Environmental

Dimensions	3.75 in. x 6.25 in. (plug-in board)
Power Requirements	+5 Vdc provided by AC Distribution Chassis
Temperature	$10^{o}C$ - $40^{o}C$
Humidity	5% - 95% Relative



Memory Bus Controller Model 2150

MEMORY BUS CONTROLLER MODEL 2150

DESCRIPTION

The Model 2150 Memory Bus Controller (MBC), which can support up to sixteen 32K Byte memory modules, provides an interface between the SEL Bus and a Memory Bus.

Through the use of 4-word deep buffers for addresses and data, the MBC can overlap up to four memory requests during a single memory cycle. Since the individual memory modules connected to the MBC have a full cycle time of 600 nanoseconds, and the SEL Bus operates synchronously with full 32-bit word transfers occurring every 150 nanoseconds, the MBC can handle the following combinations of overlapped memory operations:

- Four memory write operations (26.67M bytes/sec)
- One memory read and two memory write operations (19.99M bytes/sec)
- Two memory read operations (13.33M bytes/sec)

For memory write operations, the MBC will receive a 32-bit data word and the address of the location in memory where the data is to be stored. This information is loaded into a buffer in the MBC, and the SEL Bus is immediately free to perform another transfer during the next 150 nanosecond SEL Bus cycle.

Memory read operations require two transfers on the SEL Bus. The first transfer takes the address of the memory location to be read and the device address of the requesting device and loads them into buffers in the MBC. While the MBC is accessing the data from memory, the SEL Bus is available to other SEL Bus devices. When the data is read from memory, it is loaded into a buffer register in the MBC. The MBC then polls for SEL Bus priority. When it gains access to the SEL Bus, it transfers the data and the address of the requesting device by the SEL Bus to the requesting device.

In addition to providing control of memory read and write operations, the MBC performs error checking functions.

HIGHLIGHTS

- Supports 16 Memory Modules
- Four-Way Memory Overlap
- Error Checking

SPECIFICATIONS

Prerequisites

The Model 2150 MBC plugs into either the Model 2182 Memory Chassis or the Model 2180 Single Chassis.

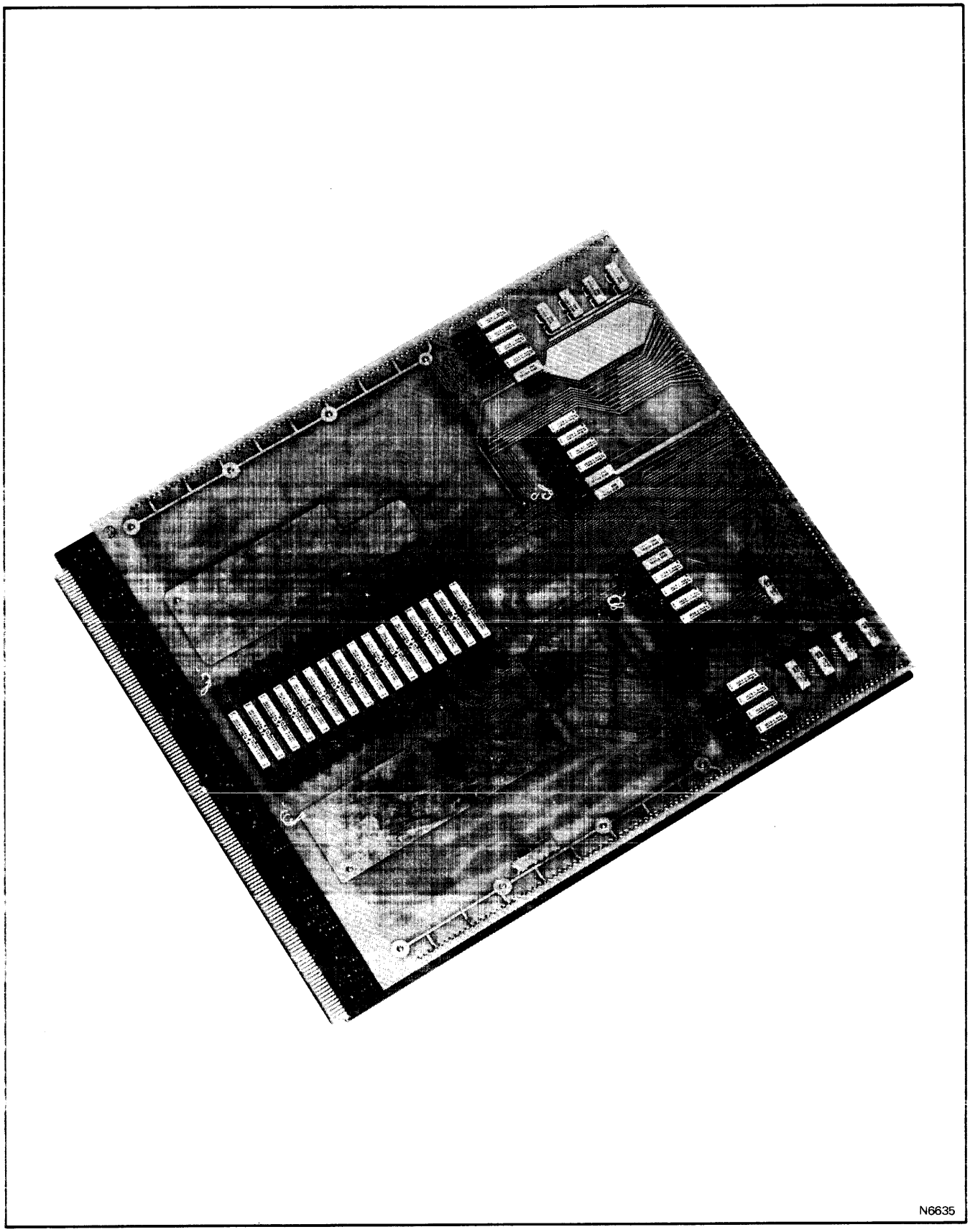
References

Technical Manual 303-322000
Technical Manual 303-322150

Physical/ Environmental

Dimensions	15 in. x 18 in. (plug-in board)
Weight	3 lb
Slot Requirements	Dedicated slot in Model 2182 or 2180.
Power Requirements	Provided by Memory Power Supply
Temp/Humidity	Same as CPU

Performance	Memory Modules/MBC	16 (512K bytes, max)
	Memory Cycle Time	600 nsec
	Thruput Rate:	
	Two Read Overlap	13.33M bytes/sec
	One Read/Two Write	19.99M bytes/sec
	Four Write	26.67M bytes/sec
	Error Checking	Byte Parity



32 KB Memory Module Model 2152

32 KB MEMORY MODULE MODEL 2152

DESCRIPTION

The Model 2152 Memory Module provides 32,768 bytes (8192 words) of 600 nanosecond memory for a SEL 32 Series Computer.

In addition to the 32 data bits in each memory word, there are 4 parity bits; one associated with each of the 4 bytes in the word. Each time a word is written into memory, parity is generated by the Memory Bus Controller, and the parity bits are stored with the word in memory. Parity is checked during all read operations; if an error is detected, a parity error trap is generated.

The Model 2152 consists of two PC boards, which are joined together to form the module. One board contains a 36 x 8192 core stack, and the other board contains the control electronics and read/write logic.

Each Model 2152 Memory Module occupies two slots in a Model 2185 Memory Chassis; or for the SEL 32/50 Single Chassis Configuration, two dedicated slots in the Model 2183 Single Chassis.

HIGHLIGHTS

- 32K Bytes (8K Words)
- 600 nsec Cycle
- Byte Parity

SPECIFICATIONS

Prerequisites

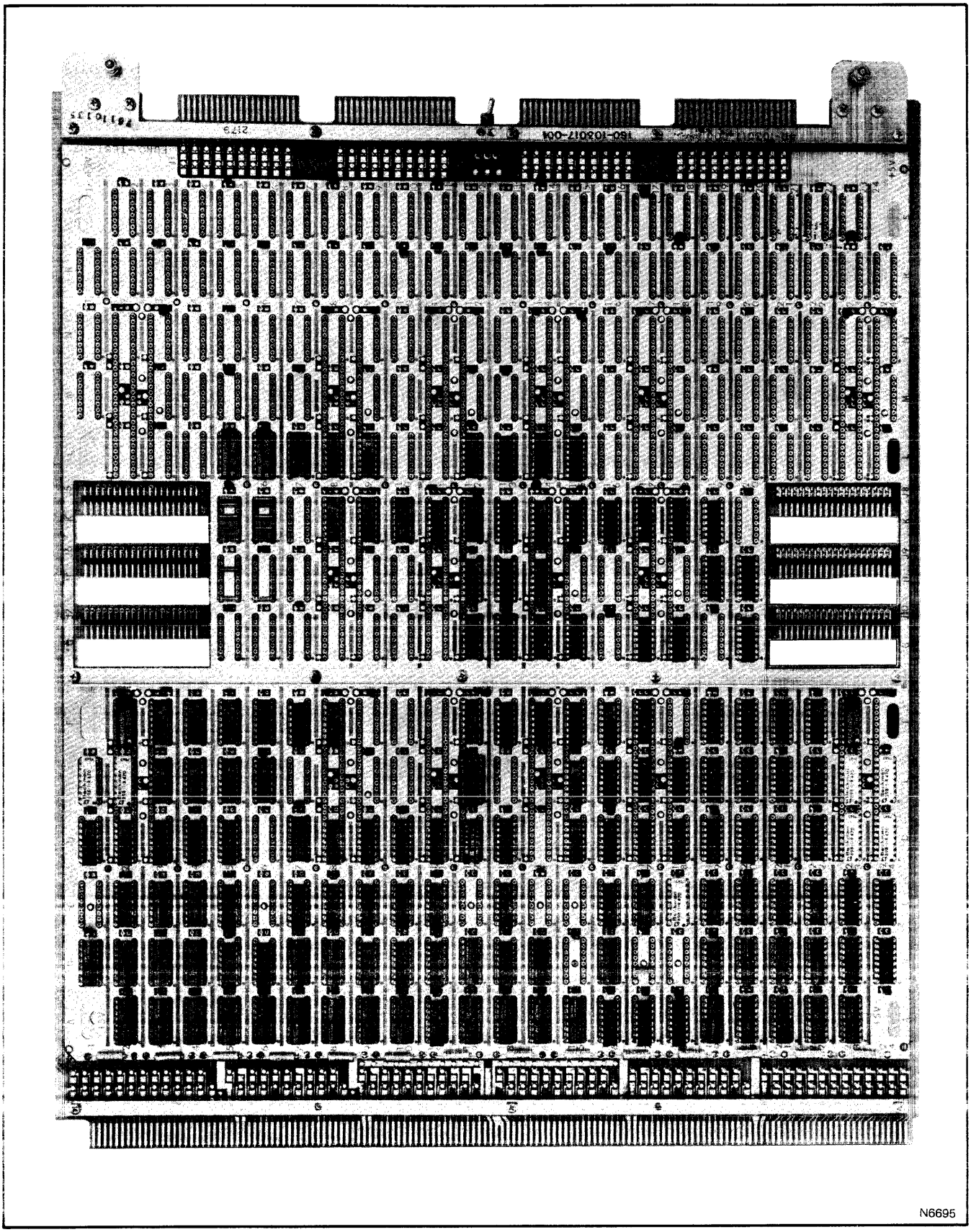
Model 2150 Memory Bus Controller for each group of 16 Memory Modules.

Model 2185 Memory Chassis for each group of eight Memory Modules, or Model 2183 Single Chassis.

References

Technical Manual 303-322150
Technical Manual 303-322152

Physical/ Environmental	Dimensions	15 in. x 18 in. (plug-in board)
	Weight	6 lb
	Memory Bus Slots Requirements	2 slots
	Power Requirements	Provided by CPU Chassis
	Environmental	Same as CPU
Performance	Memory Cycle Time	600 nsec
	Word Size	32 bits plus 4 parity bits
	Capacity (K=1024)	8192 words (8K) 32,768 bytes (32K)



Memory Interface Adapter Model 2179

MEMORY INTERFACE ADAPTER MODEL 2179

DESCRIPTION

The Model 2179 Memory Interface Adapter (MIA) is an option for use in dual processor systems and/or slow remote memory applications. The MIA provides drivers and receivers to extend the Memory Bus, thereby allowing memory modules to be remoted from the CPU cabinet. The effective cycle time of memory modules connected to the MIA is 750 nanoseconds for Write operations and 900 nanoseconds for Read operations.

The Memory Interface Adapter is on a single plug-in module and plugs directly into the SEL Bus.

HIGHLIGHTS

Extends the Memory Bus, allowing the memory modules to be remoted from the CPU cabinet.

SPECIFICATIONS

Prerequisites

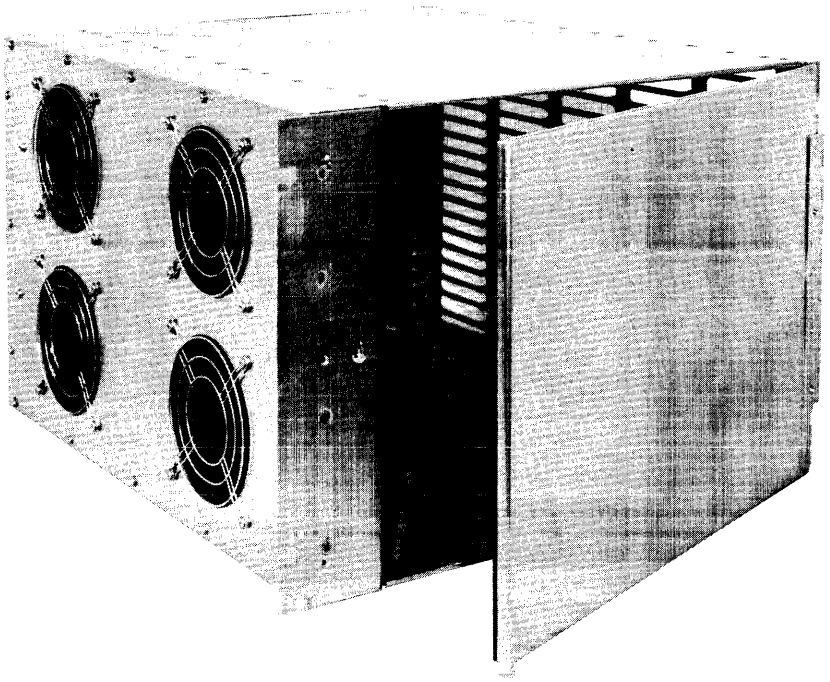
SEL 32 Computer

References

Technical Manual 325-322179

Physical/ Environmental

Dimensions	15 in. x 18 in. (plug-in board)
Weight	4 lb
SEL Bus Slot Requirements	2 slots
Power Requirements	Provided by SEL Bus
Temperature	$10^{o}C$ - $40^{o}C$
Humidity	5% - 95% Relative (Non-Condensing)
Maximum Cable Length to Memory Module	10 ft



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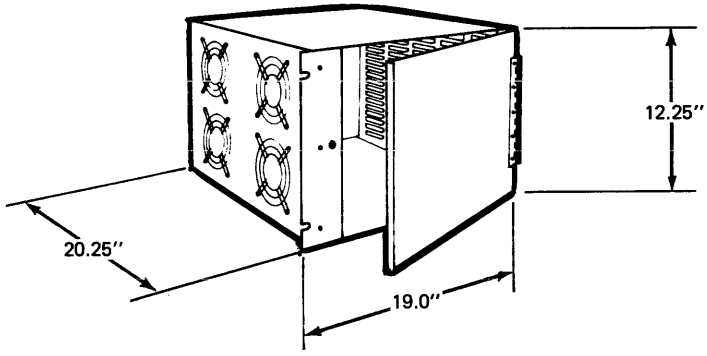


Chassis Assemblies Models 2180/2181/2182

CHASSIS ASSEMBLIES MODELS 2180/2181/2182

DESCRIPTION

Three types of chassis assemblies are available for configuring or expanding a SEL 32 Computer System. These include:

- Model 2180 Single Chassis Assembly
- Model 2181 Logic Chassis Assembly
- Model 2182 Memory Chassis Assembly

Using these chassis, two different chassis arrangements are possible; i.e., a single chassis system using the Model 2180, or a multi-chassis system using one or more Model 2181 Logic Chassis and Model 2182 Memory Chassis.

Except for the backplane PC board, all three types of chassis are identical. Spot welding is used to join the chassis parts together to form a very rugged structure.

Each chassis has 18 slots for plugging in various system modules. The modules plug into the chassis in a horizontal position. Four fans, which are mounted on the side of the chassis, provide forced air side vent cooling for the system modules.

Easy access to the system modules is provided through a hinged door on the chassis. Since all external I/O cables are connected through the backplane, individual system modules can be removed from the chassis without disturbing the external cables.

The Model 2180 is specifically designed for use in a small, single chassis system, and cannot be used in conjunction with the Model 2181 Logic Chassis or Model 2182 Memory Chassis.

The Model 2181 Logic Chassis and the Model 2182 Memory Chassis are designed to be used together in a multi-chassis system. A SEL 32 System can contain a maximum of two Model 2181 Logic Chassis and four Model 2182 Memory Chassis. However, in a standard rack configuration, there is a miximum of five chassis.

Note

Models 2180-1, 2181-1, and 2182-1 are identical to their basic models, except the cooling fans operate from 220 Vac, 50 Hz Power instead of 115 Vac, 60 Hz Power.

HIGHLIGHTS

- 19-Inch EIA Rack-Mount
- Forced Air Side Vent Cooling
- Spot Welded
- Hinged Door for Easy Access

SPECIFICATIONS

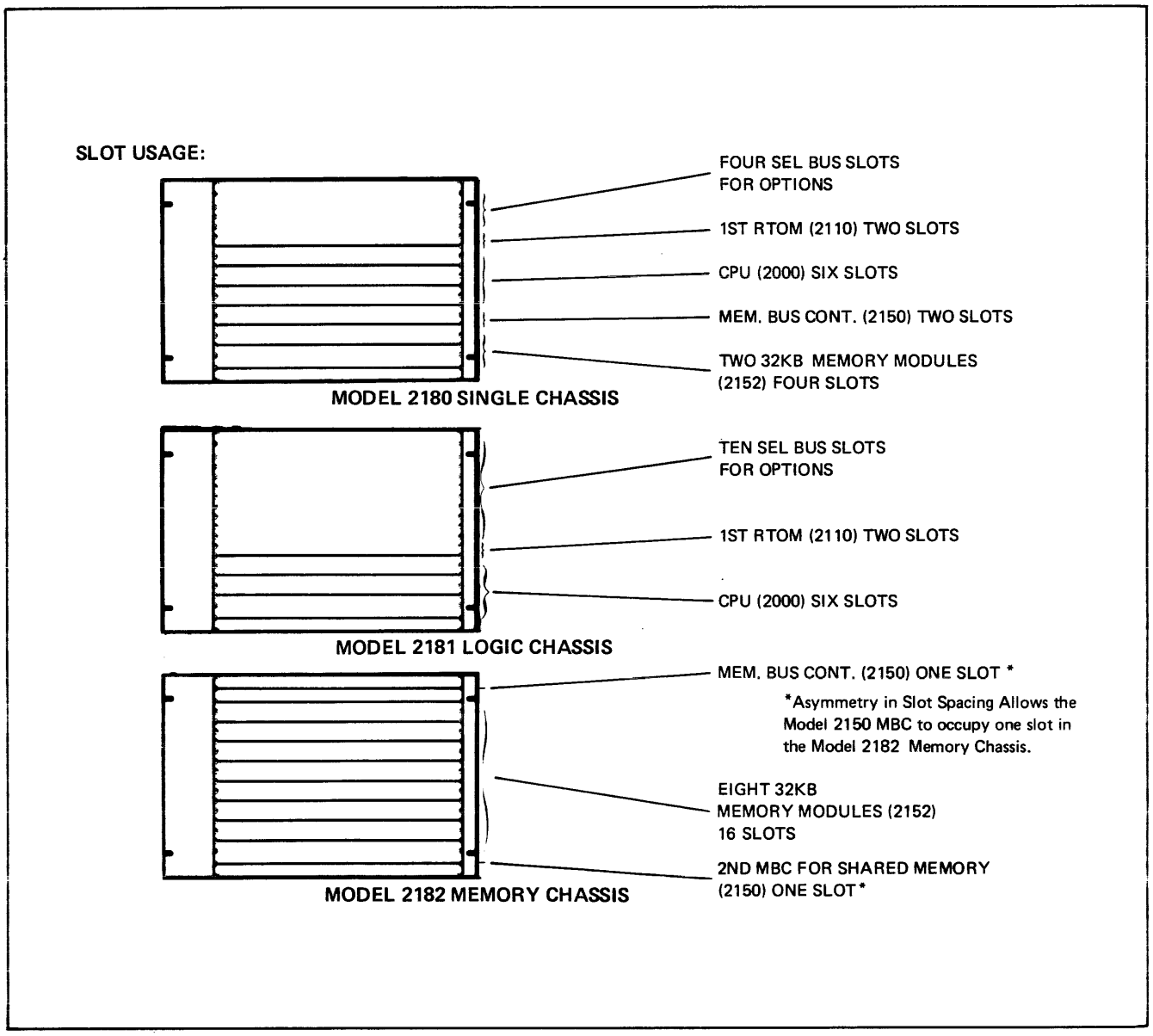
Prerequisites

SEL 32 Computer to be expanded or configured as required.

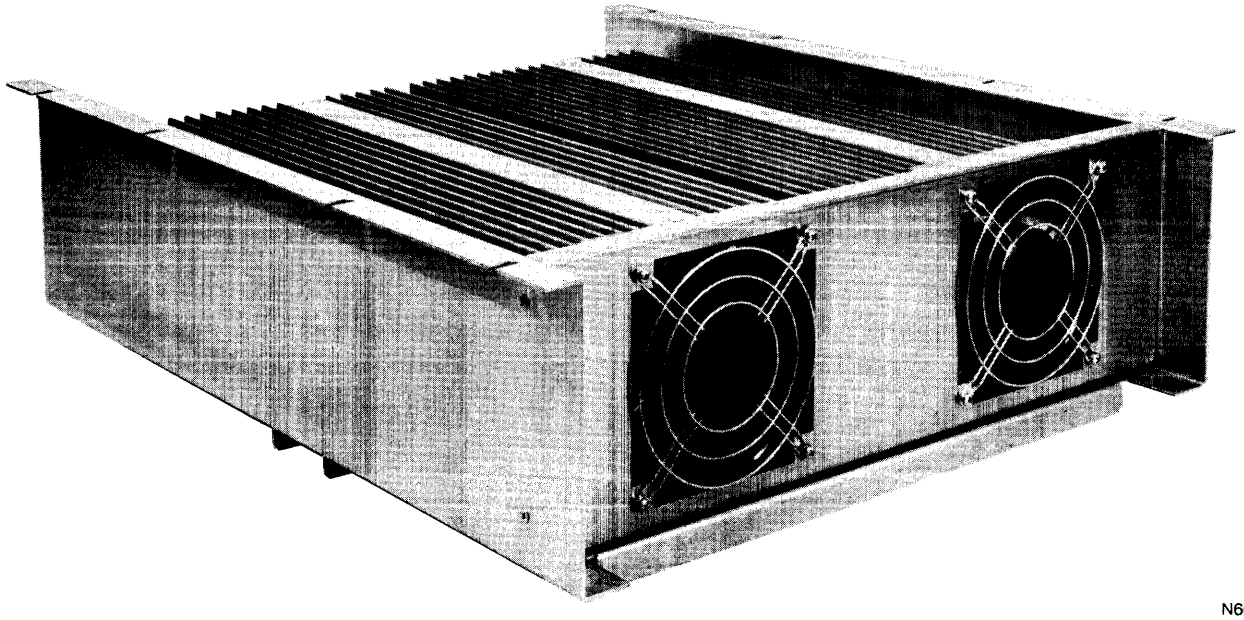
References

Technical Manual 303-322000
Technical Manual 303-322150

Physical/ Environmental	Height	12.25 in.
	Width	19.00 in.
	Depth	20.25 in.
	Weight	40 lb (empty)
	Power Requirements	
	Model 2180/2182	Provided by Model 2191 Memory Power Supply
	Model 2181	Provided by Model 2190 Logic Power Supply
	Environmental	Same as CPU



Models 2180, 2181, and 2182 Chassis



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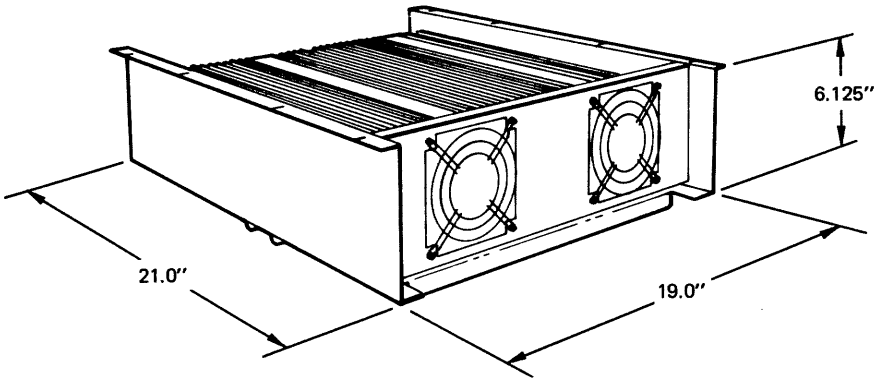


Power Supplies Models 2190/2191

POWER SUPPLIES MODELS 2190/2191

DESCRIPTION

Two types of power supply sets are available for use in configuring a SEL 32 Computer System. The Model 2190 Logic Power Supply Set provides the necessary dc power to drive one Model 2181 Logic Chassis, and the Model 2191 Memory Power Supply Set provides the necessary dc power to drive one Model 2182 Memory Chassis. Each power supply set also includes a mounting pan and blowers.

All of the power supply modules used in Models 2190 and 2191 are switching regulator types. These power supplies have high efficiencies, 65% to 70%, and are small in size for their power output.

The mounting pans may be installed in either a horizontal or vertical position. Horizontal mounting is used when the power supplies are used in a Model 2197 Single CPU Cabinet. In this type of a configuration, the cooling fans draw air in through louvers in the rear cabinet door and exhaust the warm air up through the grilled cabinet top. Vertical mounting of the power supplies is used with the Model 2198 Double CPU Cabinet. In this configuration, cool air is drawn in to the bottom of the cabinet and exhausted through the top grill.

Note

Models 2190-1 and 2191-1 are identical to their basic models except the cooling fans operate from 220 Vac, 50 Hz Power instead of 110 Vac, 60 Hz power.

HIGHLIGHTS

- Switching Regulator Type
- 65% - 70% Efficiency
- Integral Cooling Blowers

SPECIFICATIONS

Prerequisites

Model 2190 requires a Logic Chassis Model 2181 or a Single Chassis Model 2190.

Model 2191 requires a Memory Chassis Model 2182.

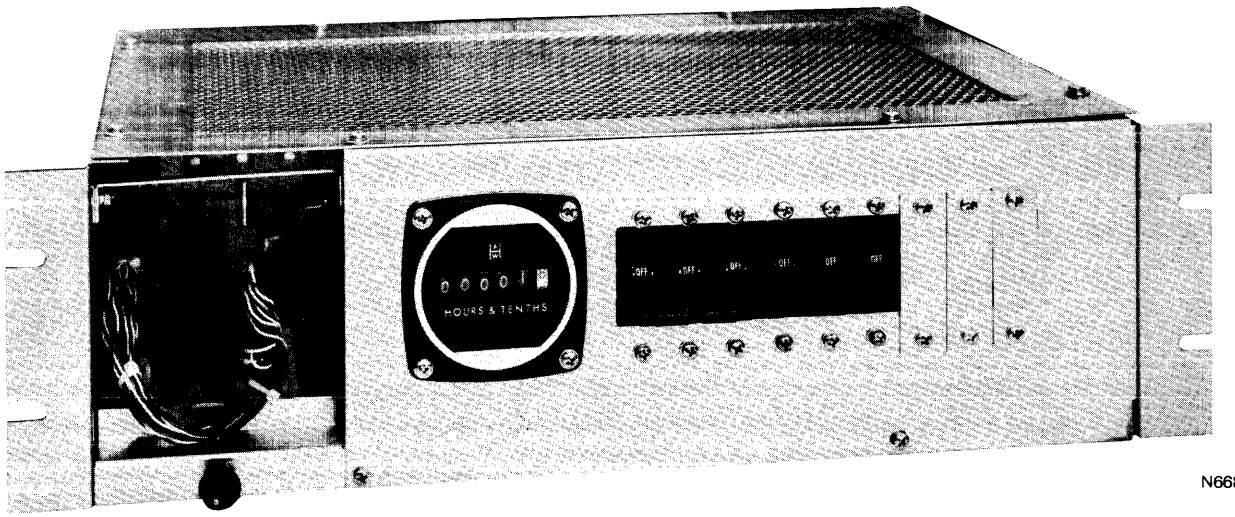
References

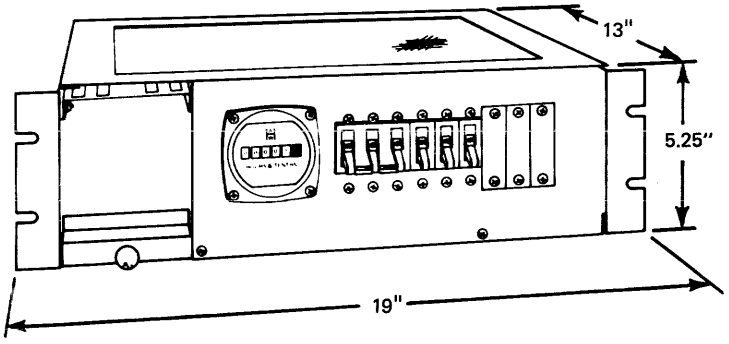
Technical Manual 303-322190

Physical/ Environmental

Height	6.125 in.
Width	19.0 in.
Depth	21.0 in.
Weight	
Model 2190	45 lb (approx.)
Model 2191	55 lb (approx.)
Power Requirements	
Voltage	115 Vac ± 10%
Frequency	48 Hz - 63 Hz
Current	9.4A (Model 2190) 9.7A (Model 2191)

	Heat Dissipation	948 Btu/hr (Model 2190) 974 Btu/hr (Model 2191)
	Environmental	
	Operating Temp	10°C - 40°C
	Relative Humidity	5% - 95% (non-condensing)
Performance	Power Supply Type	Switching Regulator
	Efficiency	65% - 70%
	Voltage Outputs	
	Model 2190	+ 5 Vdc @ 100A + 12 Vdc @ 7A
	Model 2191	+ 5 Vdc @ 100A - 5 Vdc @ 7A + 15 Vdc @ 33A - 15 Vdc @ 7A





AC Distribution Panel Model 2195

Table 3-1. SEL 32 Physical/Environmental Specifications

SEL 32 PHYSICAL / ENVIRONMENTAL SPECIFICATIONS

Model No.	Description	Dimensions (Inches) H x W x D	Service Clearance (Inches) Front	Service Clearance (Inches) Rear	Max Cable Lngth. (Ft)	Wght. (Lb)	Shipping Weight (Lb) Van	Shipping Weight (Lb) Air	Voltage	Wires	Freq Var. (Hz)	Amperage Start	Amperage Run	KVA	KW	Temp. Range (°C)	Btu (Per Hr)	Relative Humidity (%)	Altitude (Ft) -Sea	Altitude (Ft) Level+	MTBF (Hr)	MTTR (Hr)
2200	SEL 32/50 Single Chassis															10-40					2,740	0.6
2201	SEL 32/50 Min. Multi Chassis																				2,116	0.6
2202	SEL 32/55 W/32KB (8K words)	71x25x33	24	30		595	640	720	220±10%	4	60 ± 2%		16.0	1.76	3.520	10-40	6,231	5-95			1,923	0.6
2204	SEL 32/55 W/32KB (8K words)	71x25x33	24	30		699	749	829	220±10%	4	60 ± 2%		12.0	2.64	2.640	10-40	9,049	5-95			1,112	0.6
2206	SEL 32/55 W/288KB (72K words)	71x25x33	24	30		743	793	873	220±10%	4	60 ± 2%		18.0	1.98	3.960	10-40	7,060	5-95			1,056	0.6
2208	SEL 32/55 W/288KB (72K words)	71x48x33	24	30		1,147	1,198	1,288	220±10%	4	60 ± 2%	14.0	13.3	2.92	2.915	10-40	9,885	5-95			726	0.6
2210	SEL 32/55 W/544KB (136K words)	71x48x33	24	30		1,191	1,240	1,330	220±10%	4	60 ± 2%		11.0	2.42	2.420	10-40	8,189	5-95			702	0.6
2212	SEL 32/55 W/544KB (136K words)	71x48x33	24	30		1,295	1,345	1,435	220±10%	4	60 ± 2%		15.0	3.30	3.300	10-40	10,997	5-95			554	0.6
2214	SEL 32/55 W/800KB (200K words)	71x48x33	24	30		1,339	1,389	1,479	220±10%	4	60 ± 2%		12.0	2.64	2.640	10-40	9,012	5-95			62,893	0.5
2112	Additional RTOM	- x15x18	24	30		4	13	13								10-40		5-95			45,454	0.5
2142	System Control Panel	12x19x 3	24	-	5	7										10-40		5-95			200,000	0.5
2145	Hex Display		24	-		3																
2150	Memory Bus Controller (MBC)	- x15x18	24	30		4	13	13								10-40		5-95			19,685	0.5
2152	32KB Memory Module	- x15x18	24	30		6	20	20								10-40		5-95			21,459	0.5
2179	Memory Interface Adapter	- x15x18	24	30	10	4	13	13								10-40		5-95				
2181	Logic Chassis	12x19x20	24	30		40	55	55								10-40		5-95			250,000	0.5
2182	Memory Chassis	12x19x20	24	30		40	55	55								10-40		5-95			250,000	0.5
2187	Card In/Out Tool		24	-																	N/A	
2189	Test Adapter		24	30																	N/A	
2190	Logic Power Supply Set	6x19x21	24	30		45	58	58	115±10%	3	48 - 63		9.4	1.08	1.081	10-40	948	5-95			23,000	1.0
2191	Memory Power Supply Set	6x19x21	24	30		55	61	61	115±10%	3	48 - 63		9.7	1.11	1.115	10-40	974	5-95			20,000	1.0
2195	AC Distribution Panel	5x19x13	24	-					220±10%	4	60 ± 2%										71,428	0.5
2197	Single CPU Cabinet	71x25x33	24	30		(E)250	270	320	220±10%	4	60 ± 2%										N/A	
2198	Double CPU Cabinet	71x48x33	24	30		(E)500	525	595	220±10%	4	60 ± 2%										N/A	
2199	Bay Extender	71x 8x33	N/A	N/A					N/A	N/A	N/A										N/A	
9004	TLC Controller	-x15x18	24	30	30/20/60	4	13	13	N/A	N/A	N/A					10-40		5-95			13,568	0.5
9008	CDC Controller	-x15x18	24	30	30	4	13	13	N/A	N/A	N/A					10-40		5-95			15,220	0.5
9010	MHD Controller	-x15x18	24	30	50	4	13	13	N/A	N/A	N/A					10-40		5-95			14,705	0.5
9012	MT Controller	-x15x18	24	30	30	4	13	13	N/A	N/A	N/A					10-40		5-95			15,220	0.5
9014	FHD Controller	-x15x18	24	30	30	4	13	13	N/A	N/A	N/A					10-40		5-95				
7410	ADI Controller	-x15x18	24	30	AR	4	13	13	N/A	N/A	N/A					10-40		5-95				
9102	GPIO Controller	-x15x18	24	30		4	13	13	N/A	N/A	N/A					10-40		5-95			15,772	0.5
9104	GPMC Controller	-x15x18	24	30		4	13	13	N/A	N/A	N/A					10-40		5-95				
9122	ADS Controller	-x15x18	24	30		4	13	13	N/A	N/A	N/A					10-40		5-95				0.5
9124	SDS Controller	-x15x18	24	30		4	13	13	N/A	N/A	N/A					10-40		5-95				0.5
9126	CSI Controller	-x15x18	24	30		4	13	13	N/A	N/A	N/A					10-40		5-95				0.5
9132	HSD Controller	-x15x18	24	30		4	13	13	N/A	N/A	N/A					10-40		5-95				0.5
9134	SDI Controller	-x15x18	24	30		4	13	13	N/A	N/A	N/A					10-40		5-95				0.5
9201	KSR-33 Teletypewriter	33x19x19	Open	Open	30	45	130	130	115±10%	3	60 ±3/4%		1.9		0.218	5-43	1,176	30-90			3,000	1.0
9210	Card Reader (300 CPM)	11x20x14	Open	Open	60	60	100	100	115±10%	3	60 -	14.0	5.0		0.575	10-38	1,780	30-90	1,000	6,000	1,000	1.0
9211	Card Reader (1000 CPM)	16x24x18	Open	Open	60	75	110	110	115±10%	3	60 -	14.3	5.2		0.598	10-38	2,046	30-90	1,000	6,000	1,000	1.0
9216	Interpreting Data Recorder	38x48x27	Open	Open	50	300	382	382	115±10%	3	60 -		3.7		0.425	5-43	1,450	8-90			260	1.0
9217	Card Reader Punch	38x48x27	Open	Open	50	300	382	382	115±10%	3	60 -		3.7		0.425	5-43	1,450	8-90			310	1.0
9219	Card Punch	50x39x19	20	-	10	350	411	411	115±10%	3	60 ± 1	13.0	7.8		0.900	10-38	3,069	30-70	1,000	6,000	660	1.0
9224	Line Printer (125 LPM)	41x30x28	Open	12	50	275	347	347	115±10%	3	60 ± 1		3.5		0.400	10-43	1,364	95				
9225	Line Printer (300 LPM)	45x33x26	29	12	25	340	412	412	115±10%	3	60 ± 2	5.0	2.6	5.00	0.525	10-37	1,800	30-90			1,000	0.5
9226	Line Printer (600 LPM)	45x33x26	29	12	25	370	442	442	115±10%	3	60 ± 2		5.9		0.680	10-37	2,335	30-90			1,000	0.5
9301	Cartridge Disc Formatter	4x19x20	20	-	30	25	37	37	100-250±10%	3	48 - 400		.3	.03	0.030	2-50	102	10-95	0	20,000	14,000	0.6
9306	Cartridge Disc (5MB)	9x19x29	25	25	5	130	150	150	95-250±10%	3	58 - 62		9.6	1.10	1.100	10-40	3,757	5-85	0	7,500	5,865	0.5
9308	Cartridge Disc (10MB)	9x19x29	25	25	5	130	150	150	95-250±10%	3	58 - 62		9.6		1.100	10-40	3,757	5-85	0	7,500	5,865	0.5
9320	Moving Head Disc (80MB)	34x19x35	Open	12	10	218	411	516	120 +8 -18	3	59 - 66	30.0	7.0		0.690	16-32	2,350	20-80	1,000	6,000	3,000	1.5
9321	Moving Head Disc (40MB)	34x19x35	Open	12	10	218	411	516	120 +8 -18	3	59 - 66	30.0	7.0		0.690	16-32	2,350	20-80	1,000	6,000	3,000	1.5
9350	Tape Formatter 7/9 NRZI	4x19x20	20	-	30	25	37	37	100-250±10%	3	48 - 400		.3	.03	0.030	2-50	102	10-95	0	20,000	26,360	0.7
9351	Tape Formatter 9 PE	4x19x20	20	-	30	25	37	37	100-250±10%	3	48 - 400		.7		0.075	2-50	256	10-95	0	20,000	14,949	0.7
9352	Tape Formatter 7/9-9 NRZI-PE	4x19x20	20	-	30	25	37	37	100-250±10%	3	48 - 400		.8		0.100	2-50	341	10-95	0	20,000	10,214	0.6
9360	Mag Tape 7-TK NRZI-45 IPS	24x19x17	20	25	5	85	95	95	95-250±10%	3	47 - 400		2.6		0.300	2-50	1,023	15-95	0	20,000	7,981	1.0
9361	Mag Tape 9-TK NRZI-45 IPS	24x19x17	20	25	5	85	95	95	95-250±10%	3	47 - 400		2.6		0.300	2-50	1,023	15-95	0	20,000	7,981	1.0
9362	Mag Tape 9-TK PE-45 IPS	24x19x17	20	25	5	85	95	95	95-250±10%	3	47 - 400		2.6		0.300	2-50	1,023	15-95	0	20,000	7,981	1.0
9363	Mag Tape 9-TK PE/NRZI-45 IPS	24x19x17	20	25	5	85	95	95	95-250±10%	3	47 - 400		2.6		0.300	2-50	1,023	15-95	0	20,000	7,981	1.0
9374	Mag Tape 7-TK NRZI-75 IPS	24x19x17	20	25	5	115	125	125	95-250±10%	3	47 - 400		7.4		0.850	5-43	2,900	30-80	500	4,000	7,000	1.0
9375	Mag Tape 9-TK NRZI-75 IPS	24x19x17	20	25	5	115	125	125	95-250±10%	3	47 - 62		7.4	.80	0.850	5-43	2,900	30-80	500	4,000	7,000	1.0
9376	Mag Tape 9-TK PE-75 IPS	24x19x17	20	25	5	115	125	125	95-250±10%	3	47 - 62		7.4		0.850	5-43	2,900	30-80	500	4,000	7,000	1.0
9377	Mag Tape 9-TK NRZI-PE-75 IPS	24x19x17	20	25	5	115	125	125	95-250±10%	3	47 - 62		7.4		0.850	5-43	2,900	30-80	500	4,000	7,000	1.0
9397	RTP Cabinet	71x25x33				300																
9399	Peripheral Cabinet	71x25x33				250																

AC DISTRIBUTION PANEL MODEL 2195

DESCRIPTION

The Model 2195 AC Distribution Panel receives and distributes all ac power for the SEL 32 Series Computers. One AC Distribution Panel is required per system and is included in the SEL 32/55 configured systems. The Model 2195 houses the power fail detection and central timing circuitry as well as transformers, circuit breakers, and distribution components. A running time meter is mounted on the front panel (rear of rack).

Primary input power for the AC Distribution Panel is 115/230 Vac, 60 Hz, 4-wire 3-pole, single phase power. European power (230 Vac, 50 Hz, 3-wire, 2-pole, single phase) is accommodated with a variation of the basic model.

Up to 6 circuits, 10 amperes per circuit, with associated RFI line filters may be distributed from the main input power. Each power supply is connected through a corresponding filter. These filters are specifically designed for switching regulated power supplies and high common mode noise environments. Power for the chassis cooling fans is designed to be run from the same circuit as the associated dc power supply.

Power inputs are protected from high voltage transients with solid state overvoltage protection. These devices can withstand 2000 amperes peak with energy storage of 20 joules. Remote on-off control is provided by a main power contactor (coil rating - 24 volts, 400 milliamperes).

One reference transformer is dedicated to provide a reference signal, 12.6 VCT, for the power fail detector card. A second, dedicated for a high energy supply on the power fail card, is used to supply dc voltage for the power fail, central timing, and SEL Bus terminator card.

A section of the AC Distribution Panel is dedicated to housing two board assemblies and five signal/reference transformers. Two slots are available to house one or two circuit cards, depending on system configuration. The cards are internally powered with +5 Vdc and are accessible from the front of the panel. A card-edge connector, plugged to the front of each card, carries the necessary twisted pair signals to a larger signal connector at the rear of the AC Distribution Panel. During maintenance, cards may be removed and operated outside the box. Card types available to operate in these slots are:

- Power Fail Detector - One board with associated reference transformer is standard in all systems. This card also originates the signals to drive the real-time clock in the Real-Time Option Module.
- Multiprocessor Option - Provides central timing clock for dual processor configurations having shared memory.

MODEL NUMBERS

Model 2195 - Provides circuit breakers and ac distribution for up to six Power Supply Sets. Includes Power-Fail detection, and running time meter, wired for 115/230 Vac, 60 Hz, 4-wire, 3-pole, single phase primary power.

Model 2195-1 - Same as 2195 except wired for 230 Vac, 50 Hz, 3-wire, 2-pole, single phase European power.

Model 2148 - Provides central timing clock for dual processor configurations having shared memory. Timing module plugs into Model 2195 AC Distribution Panel.

Model 2148-1 - Same as 2148 except for 3-CPU configuration.

HIGHLIGHTS

- Power Fail Detection
- Central Timing Circuitry
- Zoned Power Distribution
- Overvoltage Protection

SPECIFICATIONS

Prerequisites — The Model 2195 AC Distribution Panel is included in all SEL 32/55 systems. It is an option on the SEL 32/50 systems.

References — Technical Manual 303-322000

Physical/ Environmental

Height	5.25 in.
Width	19.0 in.
Depth	13.0 in.
Weight	18 lb
Mounting	Standard EIA Rack Mount
Power Requirements:	
Voltage	115/230 Vac ±10% (Domestic) 230 Vac ±110% (European)
Frequency	60 Hz -2Hz, +3 Hz (Domestic) 50 Hz -2Hz, + 3 Hz (European)
Current	24A (max input, Domestic) 12A (max input, European)
Power	12W (internal)
Heat Dissipation	41 Btu/hr
Environmental	Operating Temperature $10^{o}C$ - $40^{o}C$
Relative Humidity	5% - 95% (non-condensing)

CABLING

INPUT/OUTPUT CONNECTIONS

All signal and power connections are made through the rear of the AC Distribution Panel. These include:

1. A 50-pin connector is used to bring out the following twisted pair signals:

Qty	Description
2	Real-Time Clocks 60 Hz (or 50 Hz on European version) to SEL Bus Terminator Card (LEXTRTC)
2	Power Fail Indicators to SEL Bus Terminator Card (LEXTPF)
3	Reset to SEL Bus Terminator Cards (LEXTRESET)
1	20 MHz for I/O timing
2	DC Power for Terminator Cards
4	Selectable Clock Phase Control to SEL Bus Terminator Cards (6.66 MHz, LEXTPHASE)
4	Primary Clock Lines (13.33 MHz, LEXTCLK)

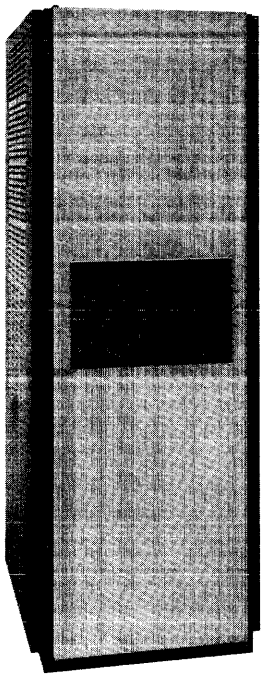
CABLING (Cont'd)

2. Distribution Output - Pairs of 115 Vac (60 Hz), 10A lines (number of pairs depends on configuration, AWG 14 max) are attached to the output barrier strip for secondary distribution of zoned power to power supplies and fans.

3. Remote Power Connection - Two screw terminals are provided for connection of the control panel for remote power control.

AC Connecting Hardware:

	60 Hz	50 Hz
Male Plug (12-ft cord)	2711 Hubbell NEMA-L14-30P	2621 Hubbell NEMA-L6-30P
Female Receptacle	2710 Hubbell NEMA-L14-30R	2620 Hubbell NEMA-L6-30R



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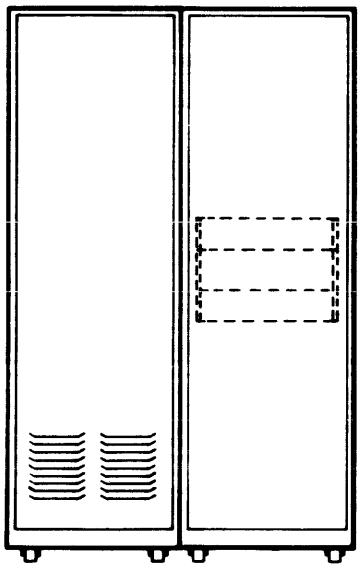
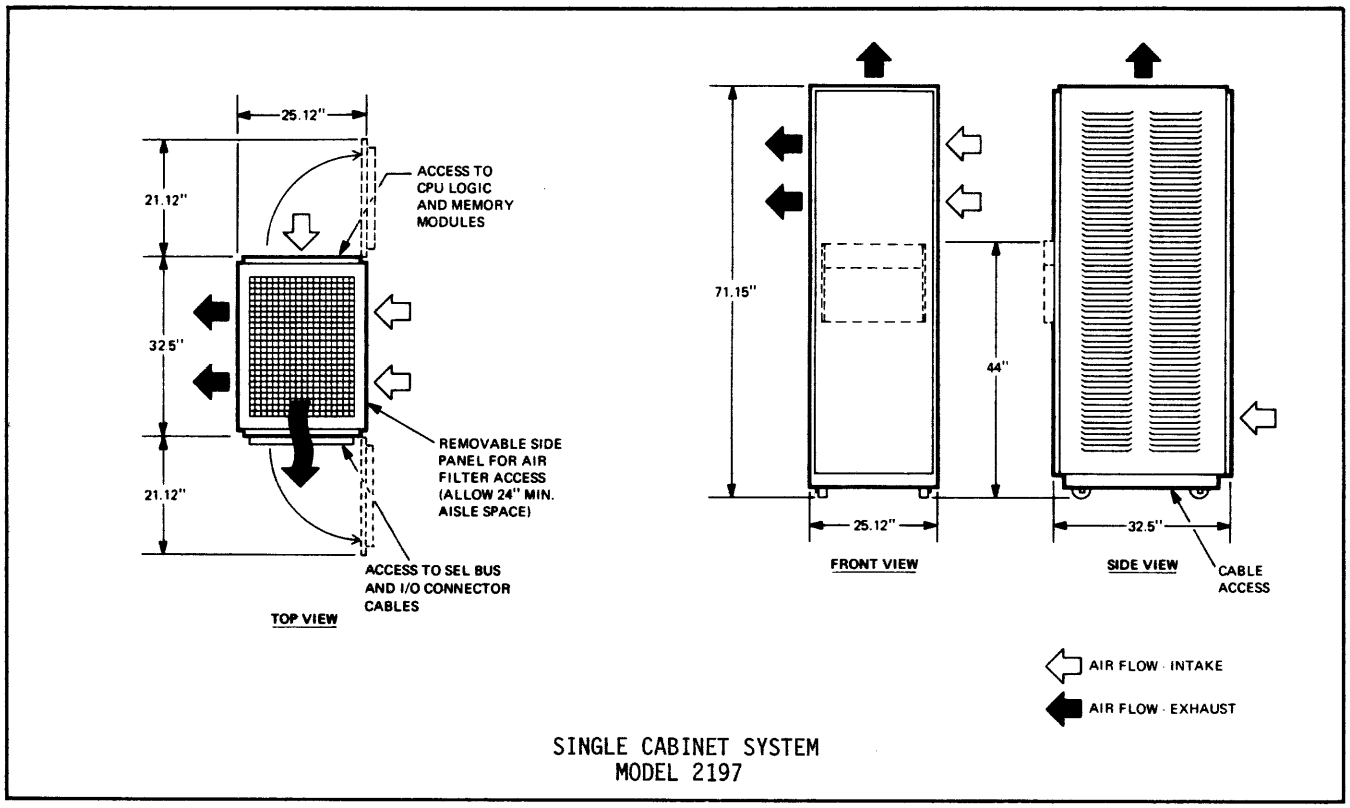
Model 2197 CPU Single Cabinet

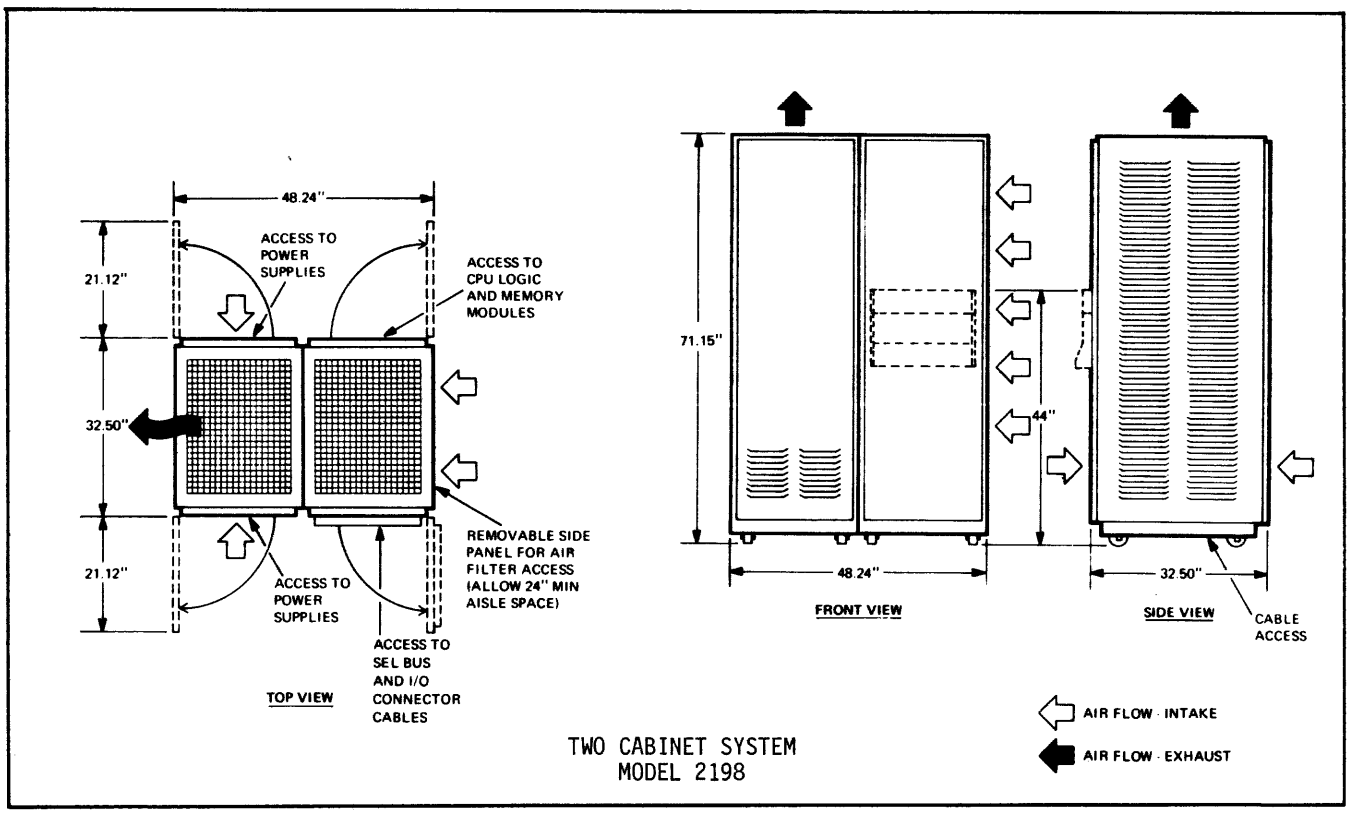


Model 2198 CPU Two Cabinet System

CPU Cabinets Models 2197/2198 and Bay Extender Model 2199



SINGLE CABINET SYSTEM
MODEL 2197



TWO CABINET SYSTEM
MODEL 2198

CPU Cabinets Models 2197/2198

CPU CABINETS MODELS 2197/2198 AND BAY EXTENDER MODEL 2199

DESCRIPTION

The Models 2197 and 2198 CPU Cabinets are used to house all component parts of a SEL 32 Computer System. The Model 2197 is a single cabinet and provides mounting for three SEL 32 Series Chassis and three power supply sets.

The Model 2198 Double CPU Cabinet, which is used for larger systems, provides mounting space for five chassis and five power supply sets. The two cabinets which make up the Model 2198 are bolted together to form a single structure. The logic and memory chassis are installed in one cabinet, and all power supply sets are installed in the other cabinet.

In addition to the chassis and power supply sets, both types of CPU Cabinets provide mounting space inside the cabinet for a Model 2195 AC Distribution Panel. Provisions for mounting the Turnkey Panel and the System Control Panel on the front door are also provided.

Louvered side panels for side vent cooling of the chassis are provided on the Model 2197 CPU Cabinet. A louvered side panel and a plain side panel are provided on the Model 2198 CPU Cabinets. These panels are easily removed for cleaning and replacement of the air filters.

The Model 2199 Bay Extender provides an 8-inch wide spacer to allow a free flow of air through the side louvers when other equipment cabinets are installed adjacent to the CPU Cabinet. The Bay Extender may be installed on either side of the CPU Cabinet, i.e., either intake or exhaust, and is not required when the CPU cabinet is the right-hand cabinet.

HIGHLIGHTS

- Single/Double Cabinets
- Side Vent Cooling

SPECIFICATIONS

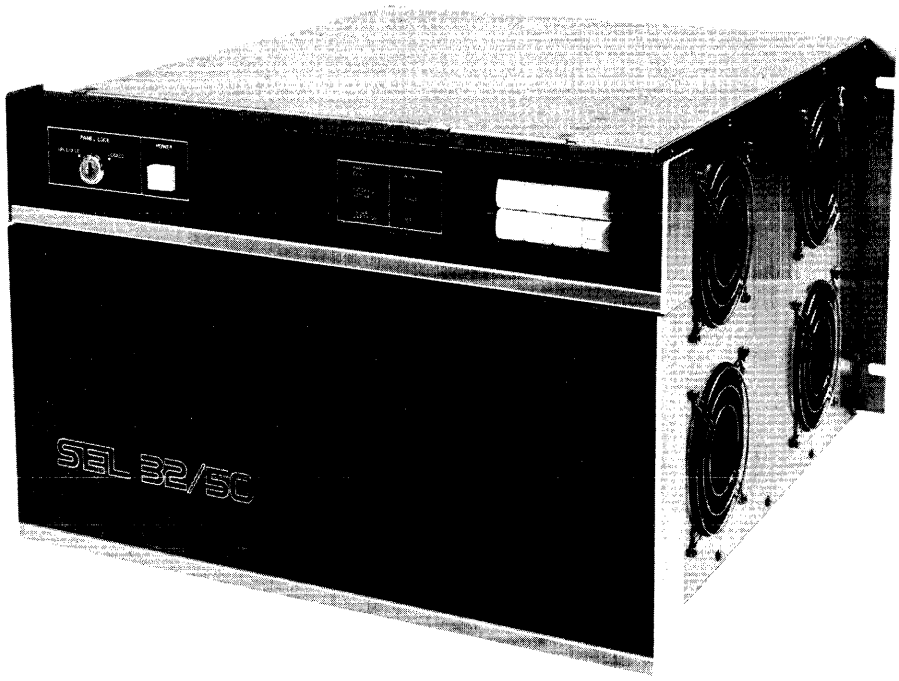
Prerequisites: SEL 32/50 Computer (configured from components)

References: Technical Manual 303-322000

Physical/ Environmental: Dimensions

Model 2197	
Height	71.15 in.
Width	25.12 in.
Depth	32.50 in.
Model 2198	
Height	71.15 in.
Width	48.24 in.
Depth	32.50 in.
Model 2199	
Height	71.15 in.
Width	8.00 in.
Depth	32.50 in.

Physical/ Environmental (Cont'd)	Weight	
	Model 2197	250 lb (empty, approx.) 750 lb (fully loaded, approx.)
	Model 2198	500 lb (empty, approx.) 1340 lb (fully loaded, approx.)
	Power Requirements	Voltage 220 Vac ±10% Frequency 60 Hz ±2%



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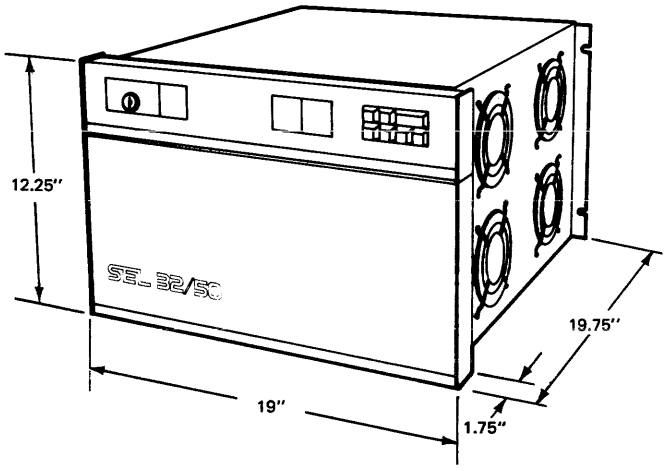
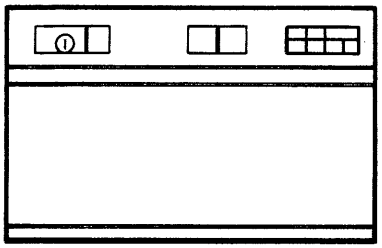
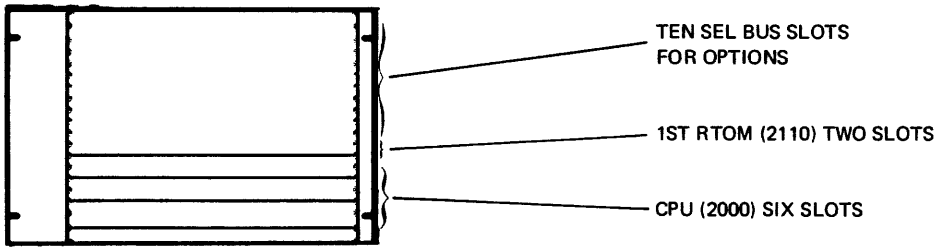


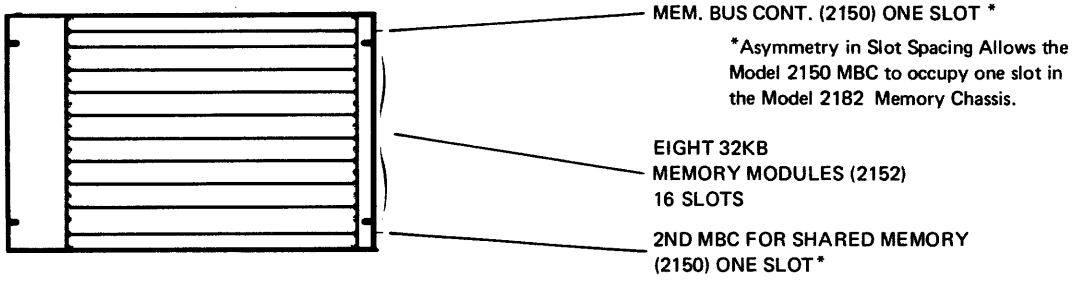
SEL 32/50 Computer Single Chassis System Model 2200



MODEL 2140 TURNKEY PANEL



MODEL 2181 LOGIC CHASSIS



MODEL 2182 MEMORY CHASSIS

SEL 32/50 Computer Minimum Multi-Chassis System Model 2201

SEL 32/50 COMPUTER MODELS 2200/2201

DESCRIPTION

The SEL 32/50, a true 32-bit virtual machine, is a state-of-the-art modular system that can be configured to meet a wide range of real-time requirements. Starting with a minimum system having 32K bytes of memory, the SEL 32/50 can be expanded with modular components into a two cabinet system with 1024K bytes of memory. Other options which can be added to a SEL 32/50 include a high-speed floating-point arithmetic unit, external interrupts, interval timers, real-time clocks, a sophisticated system control panel, special real-time interfaces, and a full complement of standard peripheral devices. In addition, SEL 32/50's may be joined in dual processor or distributed systems with both shared and private memory.

The Model 2200 is contained with the Model 2180 single chassis and is a completely integrated system. It includes a CPU with firmware floating-point, a Real-Time Option Module, a Memory Bus Controller, 32K bytes of 600 nanosecond memory, and a Turnkey Panel. The Model 2200 also provides a slot for an additional 32K byte memory module, and four SEL Bus slots for optional modules such as Input/Output Microprogrammable Processors and CPU options.

The Model 2201 SEL 32/50 Minimum Multi-chassis system provides up to 256K bytes of memory. The system is housed in the Model 2181 Logic Chassis and Model 2182 Memory Chassis. The Model 2201 system contains the basic modules that conprise the Model 2200 system and provides 7 additional slots of 32K byte memory and 10 SEL Bus Slots for options and IOM's.

HIGHLIGHTS

- Full 32-Bit Word Format
- Up to 1024K Bytes of Fast 600 Nanosecond Core Memory
- Instruction Look Ahead
- Full Memory Overlap
- Direct Memory Addressing to Bit, Byte, Halfword, Word, or Doubleword
- Standard Firmware Floating-Point
- Optional Fast Floating-Point Arithmetic Unit
- Powerful Instruction Repertoire - 152 basic Instructions
- Multi-level indirect Addressing, plus Pre and Post Indexing
- Eight 32-bit General Purpose Registers, three of which can be used for Indexing
- Fast Thruput - up to 26.67 Million Bytes per second Continuous SEL Bus Rate
- 112 Priority Interrupt Levels for I/O, External Interrupts and Traps
- Power Zoning - Chassis Individually Powered
- Individual Module On-Line/Off-Line Switches
- Standard Off-the-Shelf LSI/MSI Components
- Field-Proven Standard Software and Application Programs
- Modular Construction for Flexibility in Configuring Systems

SPECIFICATIONS

Prerequisites: See Model Numbers

References:
Reference Manual 324-322000
Technical Manual 303-322000

SYSTEM ARCHITECTURE

The system architecture for the SEL 32/50 computer is based around the concept of a virtual machine; i.e., one that exists within the firmware of a host structure.

The functional elements of the SEL 32/50 are linked by a high-speed bus, the SEL Bus. It distributes information at a rate of 26.67 million bytes per second to assure high system thruput. The modules that plug into the SEL Bus include: the Central Processor Unit, Real-Time Option Modules, Input/Output Microprogrammable Processors, and Memory Bus Controllers. In dual or distributed processing systems, Inter-Bus Links may also be added to provide communication between two SEL Buses.

All functional elements of the system consist of plug-in modules that fit into either of two types of chassis; i.e., Logic Chassis or Memory Chassis. Power zoning is provided in that each chassis is individually powered and may be turned off without shutting down the entire system. Furthermore, each plug-in module has an On-Line/Off-Line switch to allow individual modules to be electrically removed from the system without disturbing other modules.

Central Processor Unit. The SEL 32/50 Central Processor Unit is on three plug-in circuit boards. Two of the boards make up the Micro Arithmetic Logic Unit. The third board is the Micro Control Unit and it is referred to as the personality board.

Instructions on the SEL 32/50 are continuously and automatically fetched for processing, concurrently with the execution and decoding of previous instructions. Decoding is by proprietary parsing logic employing parallel ROM's for high-speed decoding.

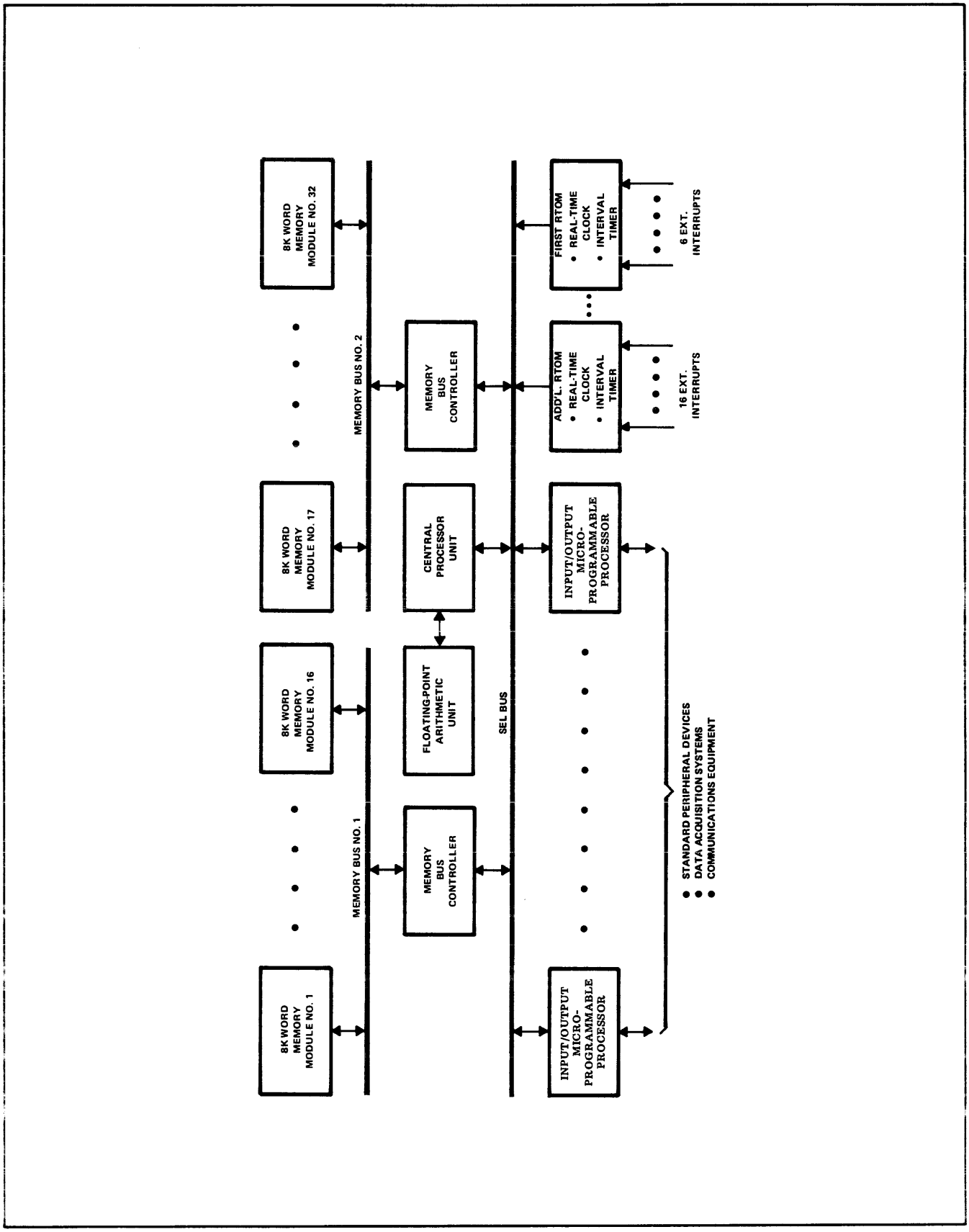
Registers. A set of eight 35 nanosecond general purpose registers is provided in the SEL 32/50 for use by the programmer for arithmetic, logical, and shift operations. Three of the eight general purpose registers (R1, R2, and R3) can be also be used for indexing operations. Register R0 can also be used as a link register, and R4 can be used as a mask register.

Addressing. The SEL 32/50 computer features two modes of memory addressing: Basic Addressing for up to 512K bytes of memory; and Extended Addressing for up to 1024K bytes of memory.

Using Basic Addressing, any byte, halfword, word, or doubleword in 512K bytes of memory can be directly addressed without mapping, indexing, or address modification.

All bits, bytes, halfwords, words, and doublewords in up to 512K bytes of memory are directly addressable in memory reference instructions. A 20-bit address field is provided for this purpose.

Bit addressing is accomplished by using the register (R) field of the instruction word to designate a bit in the byte specified by the 20-bit byte address. Therefore, any bit in memory can be directly addressed by the special set of bit-manipulation instructions. Any bit in any general purpose register can also be manipulated.



SEL 32/50 Computer Block Diagram

Instruction Repertoire. The instruction repertoire in the SEL 32/50 computer includes 154 standard instructions plus special instructions for operating in the Extended Address mode. The functional classifications and the number of instructions in each class are summarized as follows:

Class	Number
Fixed Point Arithmetic	30
Floating-Point Arithmetic	8
Boolean	17
Load/Store	30
Bit Manipulation	8
Shift	13
Interrupt	5
Compare	11
Branch	10
Register Transfer	13
Input/Output	2
Control	7
Total	154

Of particular significance are the bit-manipulation and floating-point instructions. The eight bit-manipulation instructions provide the capability to selectively set, zero, add, or test any bit in memory or register.

The eight floating-point instructions are unique because they can either be executed by the firmware in the CPU or by the optional high-speed floating-point arithmetic unit. Except for the execution speed, the presence or absence of the optional floating-point arithmetic unit is transparent to the user.

All of the instructions in the repertoire are classified as either being halfword instructions (16 bits) or fullword instructions (32 bits). The fullword instructions primarily reference memory locations, while the halfword instructions primarily deal with register operands.

Because approximately one third of the instructions are halfword instructions, program core space can be conserved by packing two consective halfword instructions into one memory location. Since the two instructions can be fetched simultaneously, there are fewer memory accesses and faster program execution. When a halfword instruction is followed by a fullword instruction, a no-op is placed in the second half of the halfword instruction.

SEL Bus. The SEL Bus, which provides a direct high-speed path between the CPU, memory, and I/O microprogrammable processors, is a high-performance time division multiplexer bus that functions at a continuous data rate of 26.67 million bytes per second. Interrupt and memory bus priority are unique and do not require module position dependence. Modules are assigned one of 24 priority levels. Priorities are changed by simple switch settings of individual modules.

The SEL Bus is a bidirectional bus. Thirty-two data lines on the SEL Bus are used to send and receive data between the CPU, Memory, and I/O Microprogrammable Processors. These transfers occur every 150 nanoseconds. Twenty-four address lines on the SEL Bus are used to address the selected I/O Microprogrammable Processor or memory location for a read or write operation. Both data and address lines operate concurrently.

Memory System. The SEL 32/50 memory is expandable in 32K byte increments up to a maximum of 1024K bytes in a double cabinet system. The memory is organized into 36-bit words: 32 data bits plus 4 parity bits, 1 parity bit per byte. The Memory Bus Controller (MBC) communicates with the SEL Bus and controls the memory bus to which the Memory Modules are attached. All transfers are 32-bit parallel. Each MBC manages up to 16 overlapped memory modules. MBC memory requests can be initiated every 150 nanoseconds. The memory modules operate asynchronously on their bus.

In multiprocessor environments, memory modules are accessible between two SEL Buses by attaching a second MBC to the memory bus to be shared.

The fast memory cycle time of the SEL 32/50 is effectively decreased through the use of memory overlapping. Therefore, at any given time the MBC can overlap up to six memory operations.

Memory Page Protect. The Memory Protect is accomplished through 512 word pages. A 16-bit register associated with each 32K byte memory module stores the protect status of each of the 16 pages in the module. Any combination of memory pages can be protected in each memory module. Instructions are provided to modify the contents of the protect registers.

Input/Output System. The power and flexibility of the SEL 32/50's I/O system is derived from two sources; intelligent I/O Microprogrammable Processors (IOM) and high-speed block oriented transfers through the SEL Bus. All IOM's for the SEL 32/50 consist of three functional parts: a SEL Bus interface, a microprogrammable processor, and a device interface. Since the SEL Bus interface and microprogrammable processor are always the same, the only difference between IOM's is the firmware for the microprogrammable processor, and the device interface. Because of the commonality of hardware, special interfaces can be implemented by simply providing new firmware and designing the device interface, which for the most part is matching signal levels between the microprogrammable processor and the device.

All I/O operations in the SEL 32/50 are handled by two I/O instructions: Command Device (CD) and Test Device (TD). Upon execution of a single CD instruction, an IOM can be conditioned to transfer a block of data between the external device and memory. Once the block transfer is intialized, the IOM takes charge of the I/O operation, and the CPU is freed to perform other tasks. When the block transfer is completed, the CPU can execute a TD instruction to test the status of the IOM to determine whether it was successful and, if not, what errors were encountered.

Interrupt/Traps. The SEL 32/50 can accomodate up to 128 hardware priority interrupt levels. These levels are used for IOM's and external signals. The interrupts associated with the I/O are provided with the IOM's, and external interrupts are added to the system through the use of Real-Time Option Modules (RTOM). These modules each provide 16 external interrupt lines and a real-time clock.

The first RTOM in the system, which is required in all configurations, is used to provide the 10 basic system interrupts and traps. These traps and interrupts, which comprise the system integrity features, include power fail, system override, memory parity, arithmetic exception, console interrupt, nonpresent memory, undefined instruction, privilege violation, call monitor, and real-time clock. The first RTOM also provides the six highest external interrupt levels.

Each interrupt level has a dedicated memory location assigned to it and is capable of being selectively enabled, disabled, activated, deactivated, or requested under software control. All interrupt control instructions are privileged, and attempts at exectuion by unprivileged programs will yield a Privilege Violation Trap.

Input/Output interrupts are of the "operation complete" variety, i.e., they signal that the requested I/O operation is complete either normally or abnormally.

SEL 32/50 Model Numbers

Model Number	Nomenclature/Configuration Notes
	CONFIGURED SYSTEMS:
2200	SEL 32/50 Single Chassis System. Provides a complete system capable of having up to 64K bytes of 600 nanosecond core memory and four SEL Bus slots for adding options and IOM's. Includes the following integrated components: CPU (2000), First RTOM (2110), Turnkey Panel (2140), MBC (2150), and one 32 KB Memory Module (2152). Does not include power supply (see 2191).

SYSTEM ARCHITECTURE (Cont'd)	Model Number	Nomenclature/Configuration Notes
	CONFIGURED SYSTEMS	
	2201	SEL 32/50 Minimum Multi-Chassis System. Provides a two chassis system capable of having up to 256 bytes 600 nanosecond core memory and 10 SEL Bus slots for options and IOM's. Includes the following components: CPU (2000), First RTOM (2110), Turnkey Panel (2140), MBC (2150), 32 KB Memory Module, Logic Chassis (2181), and Memory Chassis (2182). Does not include power supplies, AC Distribution or cabinet. May be further expanded with Models 2181 and/or 2182 chassis.
		COMPONENTS:
	2000	*Central Processor Unit (CPU). Three board CPU with firware floating-point.
	2110	*First Real-Time Option Module (RTOM). Provides 10 basic system interrupts and traps (used for system integrity features) and six highest external interrupts. If more than six external interrupts are required, order additional RTOM's (2112). One required per CPU.
	2112	Additional Real-Time Option Module (RTOM). Provides 16 external interrupt levels and a real-time clock. When the interval timer and real-time clock are used, they use 2 of the 16 external interrupts. Optional, Max seven per CPU.
	2116	Interval Timer Option. The 32-bit programmable interval timer provides selected clock rates of 300 and 600 nanoseconds; 1.2, 2.4, 4.8, 9.6, 19.2, and 38.4 microseconds. A real-time clock of 1/120th of a second and provisions to connect an external signal as the clock source.
	2120	High-Speed Floating-Point (Option). Provides for high-speed execution of floating-point instructions. Optional, Max one per CPU.
	2140	*Turnkey Panel. Provides full operator controls and indicators. One required per CPU.
	2142	System Control Panel. Provides full operator controls and indicators to augment the Turnkey Panel. Optional, Max one per CPU.
	2145	Hex Display. Provides two 9-digit hexadecimal displays for the Model 2142. Optional, Max one per System Control Panel.
	2150	*Memory Bus Controller (MBC). MBC's are required as follows: - One MBC for systems with up to 512 KB memory. - Two MBC's for systems with up to 1024 KB memory.
	2152	*32 KB Memory Module. Provides 32,768 bytes (8,192 words) of 600 nsec core memory. Min one per CPU and MBC, Max 16 per MBC, Max 32 per CPU.

*One or more of each (*) item must be included in every SEL 32/50 system. If any of these items are not included in the configuration, the customer must provide comparable components.

SYSTEM ARCHITECTURE (Cont'd)	Model Number	Nomenclature/Configuration Notes
		COMPONENTS:
	2180	Single Chassis. (refer to Model 2200 for an integrated single chassis system). May be used to configure a system with up to 64 KB memory and four SEL Bus slots for options and IOM's. Provides space for CPU, First RTOM, MBC and two memory modules. Max one per system.
	2181	*Logic Chassis. Provides 18 SEL Bus slots. Used for CPU, options and IOM's. Min one per CPU, Max two per CPU.
	2182	*Memory Chassis. Provides slots for up to eight memory modules. Min one per CPU, Max four per CPU.
	2189	Test Adapter. Provides three test sockets for maintenance purposes. Optional, mounts on 2180 or 2181.
	2190	*Logic Power Supply Set. Provides power for one Logic Chassis. Min one per system, Max two per system.
	2191	*Memory Power Supply Set. Provides power for one Memory Chassis, or one Single Chassis System. Min one per system, Max four per system.
	2195	*AC Distribution Panel. Provides circuit breakers and ac distribution for up to five power supply sets. One per system.
	2197	*Single CPU Cabinet. Provides mounting space for up to three chassis, three power supply sets, AC Distribution Panel, Turnkey Panel, and System Control Panel. Max one per system, use 2198 for larger systems.
	2198	Double CPU Cabinet. Provides mounting space for up to five chassis, five power supply sets, AC Distribution Panel, Turnkey Panel, and System Control Panel. Max one per system.
	2199	Bay Extender. Provides spacers for side vent cooling when other system cabinets (second CPU and/or peripheral cabinets) are to be installed adjacent to Models 2197 or 2198.

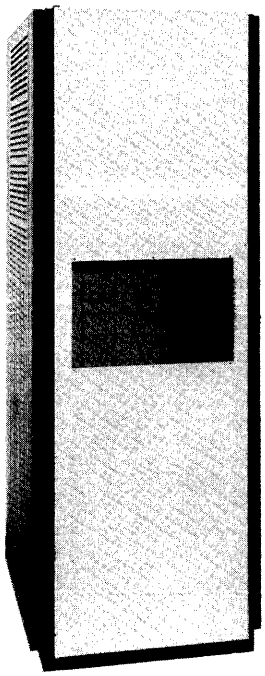
*One or more of each (*) must be included in every SEL 32/50 system. If any of these items are not included in the configuration, the customer must provide comparable components.

Physical Environmental

Chacteristic	Single Chassis Model 2180	Single Chassis Model 2197	Double Cabinet Model 2198
Dimensions			
Height	12.25 in.	72.44 in.	72.44 in.
Width	19.0 in.	22.0 in.	44.0 in.
Depth	19.75 in.	30.5 in.	30.5 in.
Weight (Lbs)			
Typical Minimum Config.	58	508	893
Typical Maximum Config.	76	1049	1343
Power			
Voltage	115 Vac ±10%	115 Vac ±10%	220 Vac ±10%
Frequency	58.8 Hz to 61.2 Hz	58.8 Hz to 61.2 Hz	58.8 Hz to 61.2 Hz
Current			
Typical Minimum	8A	16A	11A
Typical Maximum	8A	18A	15A
Heat Dissipation (Btu/hr)	3116 Max	7068 Max	11045 Max
Environmental			
Temperature			
Operating		$10^{o}C$ - $40^{o}C$	
Storage		$-25^{o}C$ - $70^{o}C$	
Relative Humidity			
Operating		5% - 95% Non-Condensing	
Storage		1% - 95% Non-Condensing	

SEL 32/50 PERFORMANCE SPECIFICATIONS

CENTRAL PROCESSOR UNIT	
Word Length	32 bits
Data Sizes	1, 8, 16, 32, 64 bits
General Purpose Registers	Eight (three of which may be used for indexing)
Additive Timing	
Memory Parity	None
Effective Address Indirect Cycle	300 nsec/indirect cycle
Indexing	None
Instruction Repertoire	
Standard Instructions	152
Floating-Point Arithmetic	Standard firmware
I/O SYSTEM	
I/O Microprocessor Thruput	1.2 Million bytes/second/IOM
I/O Mode	Block Transfer
I/O Instructions	Two (CD and TD)
SEL Bus	
Continuous Thruput	26.67 M bytes/second
INTERRUPTS	
Priority Livels	128 Max
Response Time	
Minimum	4.35 Microseconds
Maximum	17.55 Microseconds
RTOM	
Real-Time Clock Resolution	60 Hz to 120 Hz
MEMORY	
Word Size	32 data bits, plus 4 parity bits
Word Increment	8,192 Words (32,768 bytes)
Capacity	262,144 Words (1,048,576 bytes)
Speed	600 Nanosecond
Integrity Enhancements	Memory Protect Power Fail Safe Zoned Power
Medium	Non-volatile core



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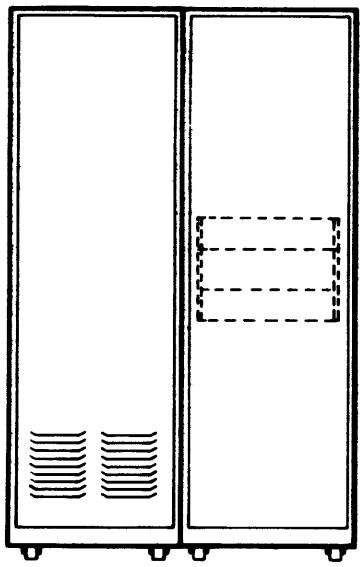
SEL 32/55 Computer Models 2202 Through 2206



SEL 32/55 Computer Models 2208 Through 2214

SEL 32/55 COMPUTER MODELS 2202-2214

DESCRIPTION

The SEL 32/55, a true 32-bit virtual machine, is a state-of-the-art modular system that can be configured to meet a wide range of real-time requirements. Starting with a minimum system having 8K words of memory, the SEL 32/55 can be expanded with modular components into a two cabinet system with 256K words of memory. Other options which can be added to SEL 32/55 include a high-speed floating-point arithmetic unit, external interrupts, interval timers, real-time clocks, a sophisticated system control panel, special real-time interfaces, and a full complement of standard peripheral devices. In addition, SEL 32/55's may be joined in dual processor or distributed systems with both shared and private memory.

Seven basic SEL 32/55 system configurations are available. Each consists of a Central Processor Unit; some initial amount of memory (either 8K, 72K, 136K, or 200K words); an I/O system with either 10 or 28 SEL Bus slots for adding options and/or I/O Microprogrammable Processors (IOM); and a turnkey control panel. All models include equipment cabinets.

The desired memory capacity for a particular system is obtained by selecting the smallest standard configuration having a memory size closest to your requirement and then simply adding 8K word memory modules to obtain the desired memory capacity.

HIGHLIGHTS

- Full 32-Bit Word Format
- Up to 256K words of fast 600 nanosecond core memory
- Instruction Look Ahead
- Full Memory Overlap
- Direct Memory Addressing to bit, byte, halfword, word or doubleword
- Standard Firmware Floating-Point
- Powerful Instruction Repertoire - 154 basic instructions
- Multi-level Indirect Addressing, plus pre and post indexing
- Eight 32-bit General Purpose Registers, three of which can be used for Indexing
- Fast Thruput - up to 26.67 million bytes per second continuous SEL Bus rate
- 128 Priority Interrupt levels for I/O, external interrupts and traps
- Power Zoning - chassis individually powered
- Individual Module On-Line/Off-Line Switches
- Standard off-the-shelf LSI/MSI Components
- Field-Proven standard software and application programs
- Modular Construction for flexibility in configuring systems

SYSTEM ARCHITECTURE

The system architecture for the SEL 32/55 Computer is based around the concept of a virtual machine; i.e., one that exists within the firmware of a host structure.

The functional elements of the SEL 32/55 are linked by a high-speed bus, the SEL Bus. It distributes information at a rate of 26.67 million bytes per second to assure high system thruput. The modules that plug into the SEL Bus include: the Central Processor Unit, Real-Time Option Modules, Input/Output Micro-

programmable Processors, and Memory Bus Controllers. In dual or distributed processing systems, Inter-Bus Links may also be added to provide communication between two SEL Buses.

All functional elements of the system consist of plug-in modules that fit into either of two types of chassis; i.e., Logic Chassis or Memory Chassis. Power zoning is provided in that each chassis in individually powered and may be turned off without shutting down the entire system. Furthermore, each plug-in module has an On-Line/Off-Line switch to allow individual modules to be electrically removed from the system without disturbing other modules.

Central Processor Unit. The SEL 32/55 Central Processor Unit is on three plug-in circuit boards. Two of the boards make up the Micro Arithmetic Logic Unit. The third board is the Micro Control Unit, and it is referred to as the personality board.

Instructions on the SEL 32/55 are continuously and automatically fetched for processing, concurrently with execution and decoding of previous instructions. Decoding is by proprietary parsing logic employing parallel ROM's for high-speed decoding.

Registers. A set of eight 35 nanosecond general purpose registers is provided in the SEL 32/55 for use by the programmer for arithmetic, logical, and shift operations. Three of the eight general purpose registers (R1, R2, and R3) can also be used for indexing operations. Register R0 can also be used as a link register, and R4 can be used as a mask register.

Addressing. The SEL 32/55 computer features two modes of memory addressing: Basic Addressing, for up to 128K words of memory and Extended Addressing, for up to 256K words of memory.

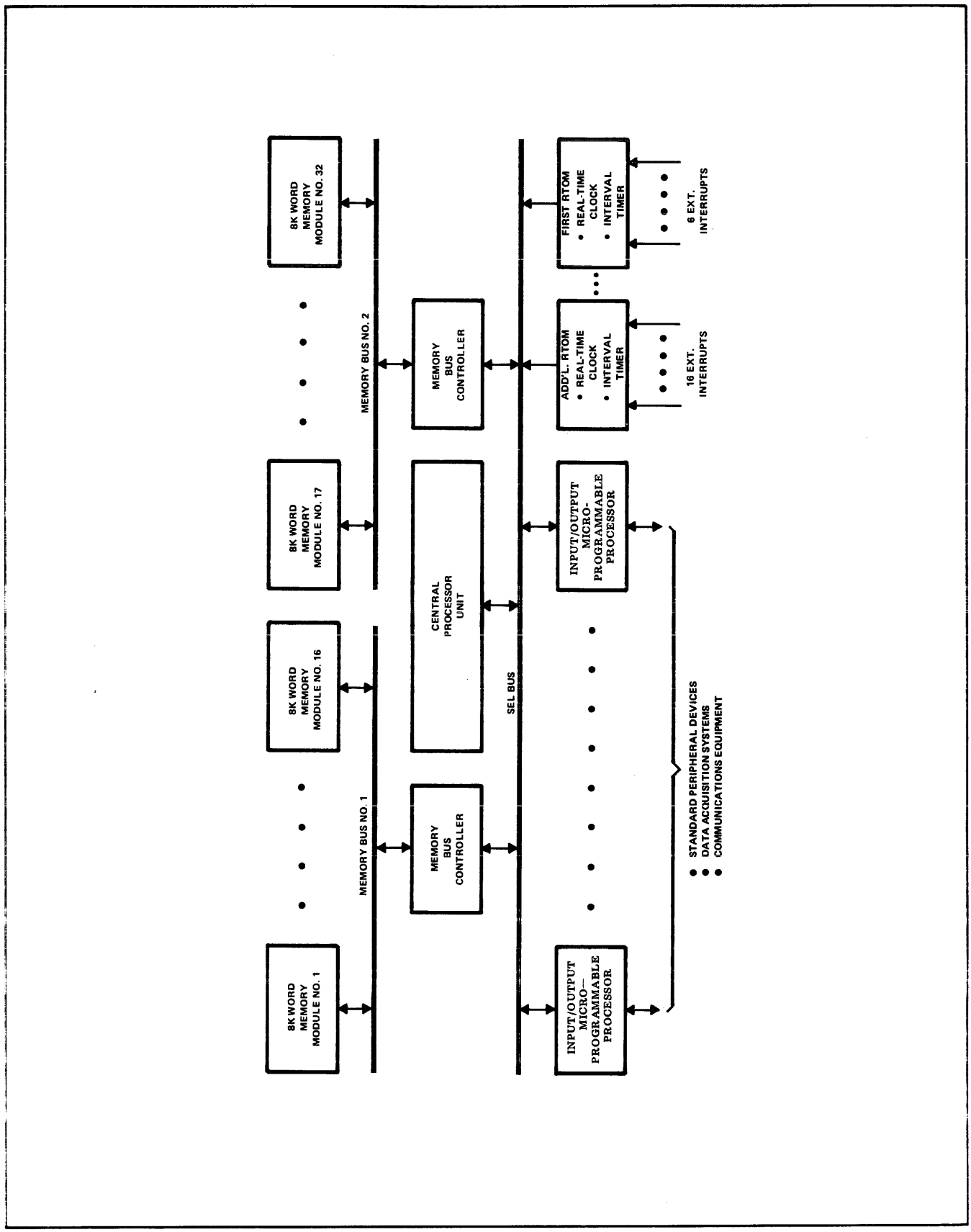
Using Basic Addressing, any byte, halfword, word, or doubleword in 128K words of memory can be directly addressed without mapping, indexing, or address modification.

All bits, bytes, halfwords, words, and doublewords in up to 128K words of memory are directly addressable in memory reference instructions. A 20-bit address field is provided for this purpose.

Bit addressing is accomplished by using the register (R) field of the instruction word to designate a bit in the byte specified by the 20-bit byte address. Therefore, any bit in memory can be directly addressed by the special set of bit-manipulation instructions. Any bit in any general purpose register can also be manipulated.

Instruction Repertoire. The instruction repertoire in the SEL 32/55 computer includes 154 standard instructions plus two special instructions for operating in the Extended Address mode. The functional classifications and the number of instructions in each class are summarized below:

Class	Number
Fixed Point Arithmetic	30
Floating-Point Arithmetic	8
Boolean	17
Load/Store	30
Bit Manipulation	8
Shift	13
Interrupt	5
Compare	11
Branch	10
Register Transfer	13
Input/Output	2
Control	7
Extended Address	2
Total	154



SEL 32/55 Computer Block Diagram

Of particular significance are the bit-manipulation and floating-point instructions. The eight bit-manipulation instructions provide the capability to selectively set, zero, add, or test any bit in memory or register.

The eight floating-point instructions are unique because they can either be executed by the firmware in the CPU or by the optional high-speed floating-point arithmetic unit. Except for the execution speed, the presence or absence of the optional floating-point arithmetic unit is transparent to the user.

All of the instructions in the repertoire are classified as either being halfword instruction (16 bits) or fullword instructions (32 bits). The fullword instructions primarily reference memory locations while the halfword instructions primarily deal with register operands.

Because approximately one third of the instructions are halfword instructions, program core space can be conserved by packing two consective halfword instructions into one memory location. Since the two instructions can be fetched simultaneously, there are fewer memory accesses and faster program execution. When a halfword instruction is followed by a fullword instruction, a no-op is placed in the second half of the halfword instruction.

SEL Bus. The SEL Bus, which provides a direct high-speed path between the CPU, memory, and I/O microprogrammable processors, is a high-performance time division multiplexer bus that functions at a continuous data rate of 26.67 million bytes per second. Interrupt and memory bus priority are unique and do not require module position dependence. Modules are assigned one of 24 priority levels. Priorities are changed by simple switch settings of individual modules.

The SEL Bus is a bidirectional bus. Thirty-two data lines on the SEL Bus are used to send and receive data between the CPU, memory and I/O Microprogrammable Processors. These transfers occur every 150 nanoseconds. Twenty-four address lines on the SEL Bus are used to address the selected I/O Microprogrammable Processor or memory location for a read or write operation. Both data and address lines operate concurrently.

Memory System. The memory is organized into 36-bit words: 32 data bits plus 4 parity bits, 1 parity bit per byte. The Memory Bus Controller (MBC) communicates with the SEL Bus and controls the memory bus to which the memory modules are attached. All transfers are 32-bit parallel. The MBC manages up to 16 overlapped memory modules. MBC memory requests can be initiated every 150 nanoseconds. The memory modules operate asynchronously on their bus.

In multiprocessor environments, memory modules are accessible between two SEL Buses by attaching a second MBC to the memory bus to be shared.

The fast memory cycle time of the SEL 32/55 is decreased through the use of memory overlapping. The MBC can accept a memory transfer every 150 nanoseconds. Therefore at any given time the MBC can overlap up to six memory operations.

Expansion to 256K Words. The SEL 32/55 is available in four different basic memory configurations. These basic configurations, combined with optional 8K word memory modules, provide memory capacities from 8K words to 256K words in increments of 8K words. The amount of memory and the inherent memory expansion for these configurations are summarized below:

Models	Included Memory	Inherent Expansion to
2202/2204	8 KW	64 KW
2206/2208	72 KW	128 KW
2210/2212	136 KW	192 KW
2214	200 KW	256 KW

Because of the way that each configuration has been defined, memory can be expanded (at the time of the initital order or as a field add-on) by simply adding 8K word memory modules to the basic configuration to obtain the desired

memory capacity. Within these limits, no additional hardware (such as chassis, racks, power supplies, or Memory Bus Controllers) is required.

Field expansion of a system beyond the inherent memory expansion capability is accomplished through the use of Memory Upgrade Kits. These kits include all of the required chassis, racks, power supplies, and Memory Bus Controllers to upgrade a configuration to the next larger size.

Memory Pate Protect. The Memory Protect is accomplished through 512 word pages. A 16-bit register associated with each 8K memory module stores the protect status of each of the 16 pages in the module. Any combination of memory pages can be protected in each memory module. Instructions are provided to modify the contents of the protect registers.

Input/Output System. The power and flexibility of the SEL 32/55's I/O system are derived from two sources; intelligent I/O Microprogrammable Processors (IOM) and high-speed block oriented transfers through the SEL Bus. All IOM's for the SEL 32/55 consist of three functional parts: a SEL Bus interface, a microprogrammable processor, and a device interface. Since the SEL Bus interface and microprogrammable processor are always the same, the only difference between IOM's is the firmware for the microprogrammable processor, and the device interface. Because of the commonality of hardware, special interfaces can be implemented by simply providing new firmware and designing the device interface, which for the most part is matching signal levels between the microprogrammable processor and the device.

All I/O operations in the SEL 32/55 are handled by two I/O instructions: Command Device (CD) and Test Device (TD). Upon execution of a single CD instruction, an IOM can be conditioned to transfer a block of data between the external device and memory. Once the block transfer is initialized, the IOM takes charge of the I/O operation, and the CPU is freed to perform other tasks. When the block transfer is completed, the CPU can execute a TD instruction to test the status of the IOM to determine whether it was successful and, if not, what errors were encountered.

Interrupts/Traps. The SEL 32/55 can accommodate up to 128 hardware priority interrupt levels. These levels are used for IOM's and external signals. The interrupts associated with the I/O are provided with the IOM's, and external interrupts are added to the system through the use of Real-Time Option Modules (RTOM). These modules each provide 16 external interrupt lines and a real-time clock.

The first RTOM in the system, which is included in all configurations, is used to provide the ten basic system interrupts and traps. These traps and interrupts which comprise the system integrity features, include power fail, system override, memory parity, arithmetic exception, console interrupt, non-present memory, undefined instruction, privilege violation, call monitor, and real-time clock. The first RTOM also provides the six highest external interrupt levels.

Each interrupt level has a dedicated memory location assigned to it and can be selectively enabled, disabled, activated, deactivated, or requested under software control. All interrupt control instructions are privileged, and attempts at execution by unprivileged programs will yield a Privilege Violation Trap.

Input/Output interrupts are of the "operation complete" variety, i.e., they signal that the requested I/O operation is complete either normally or abnormally.

Turnkey Panel. A Turnkey Panel, which is provided as part of each SEL 32/55 Computer, provides the basic controls and indicators for the system. Featured on this panel is a key-lock switch to provide system security against unauthorized control of the system.

The functional controls of the Turnkey Panel include: Run/Halt, System Reset, Attention, Initial Program Load (Bootstrap), and Clock Override. The key-lock switch has two positions for enabling or disabling the Turnkey Panel function keys. The key-lock switch also applies to the optional System Control Panel

Panel when it is included in the system. When the key is turned to locked, the key may be removed, and all function keys are disabled except for the Attention Key and the System Control Panel logic associated with loading and reading control switches.

Light Emitting Diodes are used for status indicators. These include: Parity Error, Interrupt Active, Wait, Run, Halt, and Clock Override.

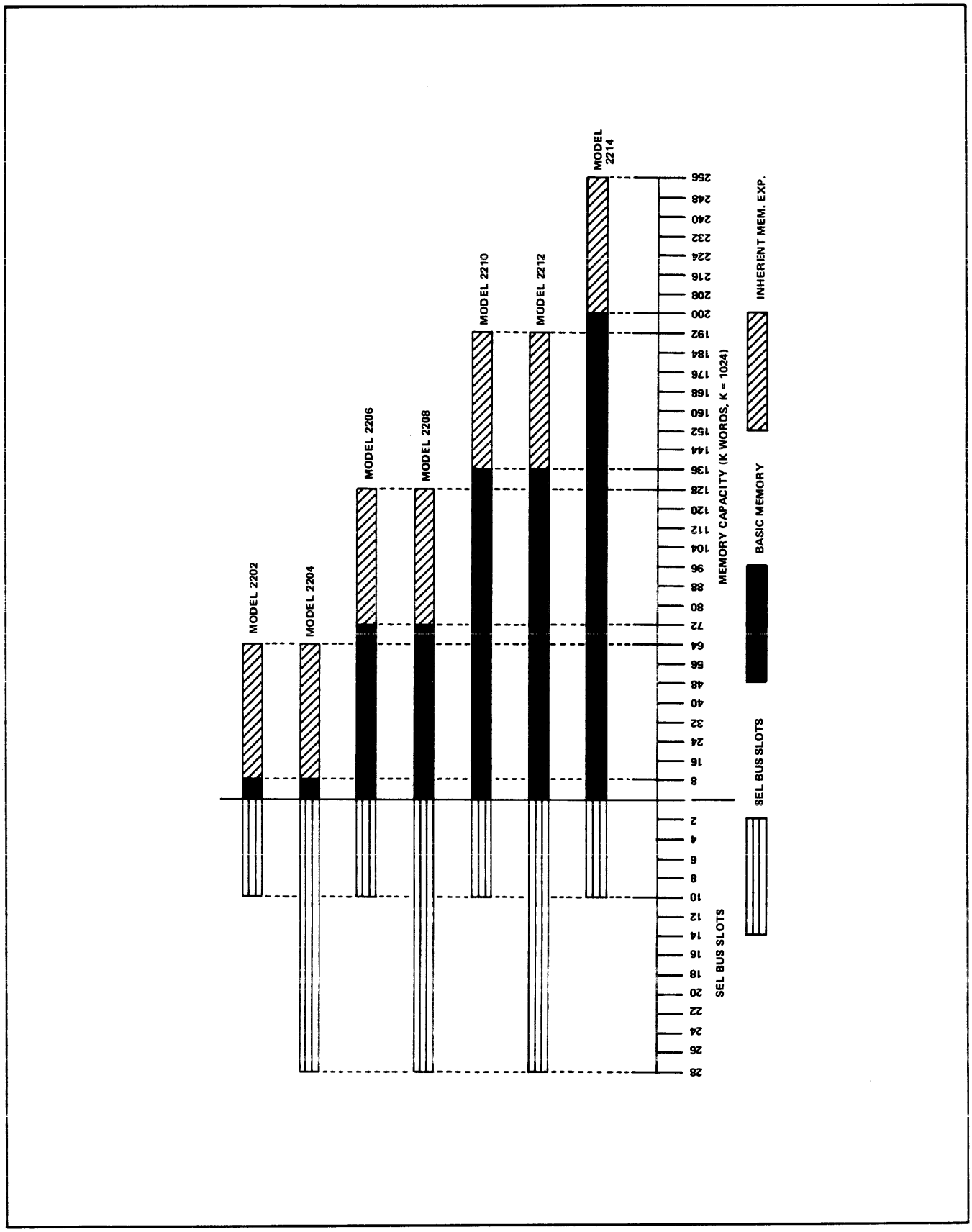
Should additional operator controls and indicators be required, the optional System Control Panel may be included.

SEL 32/55 Model Numbers. All SEL 32/55 Computer Configurations include a CPU with firmware floating-point, a Turnkey Panel, some amount of 600 nanosecond core memory (either 8K, 72K, 136K, or 200K words), the first Memory Bus Controller, the first RTOM for the basic system interrupts and traps, an AC Distribution Panel, power supplies, and equipment cabinet(s).

Model	Nomenclature/Description
2202	SEL 32/55 Computer with 8 KW Memory (32 KB). Provides inherent memory expansion to 64K words (256 KB) and 10 SEL Bus slots. In single cabinet.
2204	SEL 32/55 Computer with 8 KW Memory (32 KB) and Ext. I/O. Provides inherent memory expansion to 64K words (256 KB) and 28 SEL Bus Slots. In single cabinet.
2206	SEL 32/55 Computer with 72 KW Memory (288 KB). Provides inherent memory expansion to 128K words (512 KB) and 10 SEL Bus Slots. In single cabinet.
2208	SEL 32/55 Computer with 72 KW Memory (288 KB) and Ext. I/O. Provides inherent memory expansion to 128K words (512 KB) and 28 SEL Bus Slots. In double cabinet.
2210	SEL 32/55 Computer with 136 KW Memory (544 KB). Includes second MBC and provides inherent memory expansion to 192 K words (768 KB) and 10 SEL Bus Slots. In double cabinet.
2212	SEL 32/55 Computer with 136 KW Memory (544 KB) and Ext. I/O. Includes second MBC and provides inherent memory expansion to 192K words (768 KB) and 28 SEL Bus slots. In double cabinet.
2214	SEL 32/55 Computer with 200 KW Memory (800 KB). Includes second MBC and provides inherent memory expansion to 256K words (1024 KB) and 10 SEL Bus Slots. In double cabinet.

CPU and Memory Options

Model	Nomenclature/Description
2112	Real-Time Option Module (RTOM). Provides 16 external interrupts and a real-time clock. Requires two SEL Bus Slots.
2142	System Control Panel. Provides full operator controls and indicators of system status. Requres two SEL Bus Slots.
2145	Hex Display. Provides two hexadecimal displays (nine digits each) for System Control Panel.



SEL 32/55 Computer Configurations

SYSTEM ARCHITECTURE (Cont'd)

Model	Nomenclature/Description
2152	8K Word (32 KB) Core Memory Module. Provides 8,192 words (32,768 bytes) of 600 nanosecond core memory for the SEL 32 Series Computers.

SPECIFICATIONS

Prerequisites: See Model Numbers

References: Reference Manual SEL 32, 324-322000
Technical Manual SEL 32, 303-322000

Physical/ Environmental

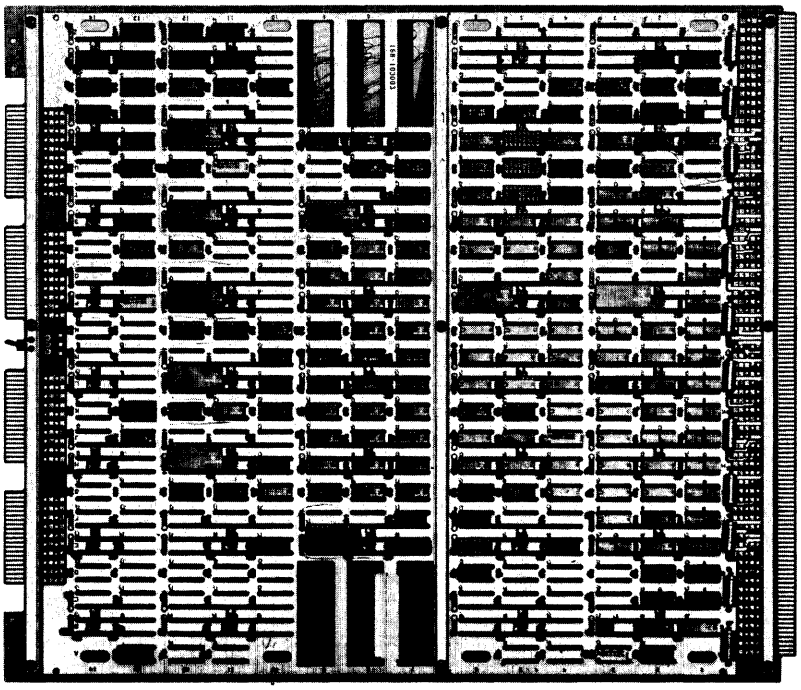
	Model Number						
	2202	2204	2206	2208	2210	2212	2214
Dimensions (Inches)							
Height		71.15			71.15		
Width		25.12			48.25		
Depth		32.50			32.50		
Weight (Lbs)							
Basic Config.	508	598	656	1046	1104	1194	1252
Fully Exp.	595	699	743	1147	1191	1295	1339
Power (See Note)							
Voltage	115 Vac ±10%	220 Vac ±10%	115 Vac ±10%		220 Vac ± 10%		
Frequency (Hz)	58.8 - 61.2	58.8 - 61.2	58.8 - 61.2		58.8 - 61.2		
Current (Max)	16A	12A	18A	13.25A	11A	15A	12A
Heat Dissipation							
Btu/hr (Max)	6231	9049	7060	9885	8189	10997	9012
Environmental							
Oper. Temperature	10°C - 40°C						
Oper. Humidity	5% - 95% Non-Condensing						
Storage Temp.	25°C - 70°C						
Storage Humidity	1% - 95% Non-Condensing						

SEL 32/55 PERFORMANCE SPECIFICATIONS

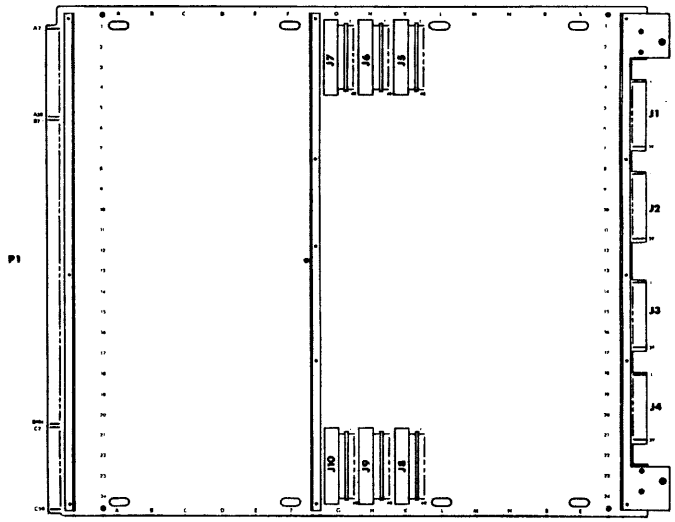
CENTRAL PROCESSOR UNIT	
Word Length	32 bits
Data Sizes	1, 8, 16, 32, 64 bits
General Purpose Registers	Eight (three of which may used for indexing)
Additive Timing	
Memory Parity	None
Effective Indirect Address Cycle	300 nsec/indirect cycle
Indexing	None
Instruction Repertoire	
Standard Instructions	154
Floating-Point Arithmetic	Standard firmware
I/O SYSTEM	
I/O Microprogrammable Processor Thruput	1.2M bytes/second/IOM
I/O Mode	Block Transfer
I/O Instructions	Two (CD and TD)
SEL Bus	
Continuous Thruput	26.67M bytes/second
INTERRUPTS	
Priority Levels	128 Max
Response Time	
Minimum	4.35 Microseconds
Maximum	17.55 Microseconds
RTOM	
Real-Time Clock Resolution	60 Hz or 120 Hz
MEMORY	
Word Size	32 data bits, plus 4 parity bits
Word Increment	8,192 Words (32,768 bytes)
Capacity	262,144 Words (1,048,576 bytes)
Speed	600 Nanosecond
Integrity Enhancements	Memory Protect Power Fail Safe Zoned Power
Medium	Non-volatile core

INPUT/OUTPUT MICROPROGRAMMABLE CONTROLLER BOARDS

The following Controllers Models 90XX and 91XX are configured on universal 15 in. x 18 in. plug-in boards as shown below.



N6637



Controller Boards

TLC CONTROLLER MODEL 9004

DESCRIPTION

The Model 9004 TLC Controller is a compact and versatile multi-device Input/Output Microprogrammable Processor (IOM) for the SEL 32 Series Computers. The Model 9004, which is on a single plug-in module, provides I/O control for a teletypewriter, a line printer, and a card reader.

Like all other standard IOM's for the SEL 32 Series Computers, the TLC Controller plugs directly into the SEL Bus. The five functional parts of the TLC Controller are: the SEL Bus interface, the Microprogrammable Processor, a teletypewriter interface, a line printer interface, and a card reader interface.

The SEL Bus interface includes drivers and receivers for data and control lines on the SEL Bus, a 32-bit buffer register, and a toggle switch for electrically disconnecting the TLC Controller from the SEL Bus.

The firmware in the microprogrammable processor has been implemented to respond to the SEL 32 Series Computer's I/O instructions; i.e., the Command Device (CD) and Test Device (TD) instructions.

Through the execution of a single CD instruction by the CPU, any one of the three channels in the TLC Controller can be conditioned for a block transfer. Once the block transfer has been initialized, the TLC Controller takes full control over the operation, and the CPU is free to perform other tasks.

When the block transfer is completed, the TLC Controller signals the CPU by an interrupt. The CPU can then execute a TD instruction to determine whether the transfer was successful and, if not, what errors were encountered.

The teletypewriter, line printer and card reader channels on the TLC Controller operate concurrently through the use of individual buffers and I/O interrupts for each device.

HIGHLIGHTS

- Teletypewriter Channel
- Line Printer Channel
- Card Reader Channel

SPECIFICATIONS

Prerequisites: SEL 32 Computer

References: Technical Manual 325-329004

Physical/ Envrionmental

Dimensions	15 in. x 18 in. (plug-in board)
Weight	4 lb
SEL Bus Slot Requirements	2 slots (Model (9004) 1 slot (Model 9005)
SEL Bus Electrical Load	1 load
Power Requirements	Provided by SEL Bus
Temperature	10°C - 40°C
Humidity	5% - 95% Relative

Physical/ Environmental (Cont'd)	Maximum Cable Length to:		
	TTY	30 ft	
	LP	30 ft	
	CR	30 ft	
Performance	Maximum IOM Thruput		1.2M bytes/sec
	Number of Devices		1 each; TTY, LP and CR
	Compatible Devices:		
	TTY Channel		Model 9201 KSR-33, or equivalent device with 20 MA current loop or RS232 Interface and jumper selectable baud rates.
	LP Channel		Model 9224 LP (125 lpm) Model 9225 LP (300 lpm) Model 9226 LP (600 lpm)
	CR Channel		Model 9210 CR (300 cpm) Model 9211 CR (1000 cpm)

CARTRIDGE DISC CONTROLLER MODEL 9008

DESCRIPTION

The Model 9008 Cartridge Disc Controller is a standard SEL 32 Input/Output Microprogrammable Processor (IOM) which provides an interface between a SEL 32 Series Computer and the Model 9301 Cartridge Disc Formatter.

The Cartridge Disc Controller is on a single plug-in module which plugs directly into the SEL Bus and consists of three parts: the SEL Bus interface, the Microprogrammable Processor (MP), and the formatter interface.

The SEL Bus interface includes drivers and receivers for data and control lines on the SEL Bus, a 32-bit buffer register, and an On-Line/Off-Line switch. This toggle switch electrically disconnects the Cartridge Disc Controller from the SEL Bus without removing the board from the chassis.

The MP, which includes a ROM, has firmware to permit it to respond to Command Device (CD) and Test Device (TD) instructions from the CPU for the Cartridge Disc System. Upon execution of a single CD instruction, the Model 9008 can be conditioned to transfer a block of data between a selected cartridge disc drive and memory.

Once the block transfer is initialized, the cartridge disc controller takes charge of the I/O operation, and the CPU is freed to perform other tasks.

When a block transfer is completed, the controller signals the CPU by an interrupt. The CPU can then execute a TD instruction to determine whether the transfer was successful and, if not, what errors were encountered.

The cartridge disc interface consists of drivers and receivers to match signal levels between the controller and the Model 9301 Cartridge Disc Formatter.

HIGHLIGHTS

- 312K Byte Transfer Rate
- 4 Disc Drives/Controller

SPECIFICATIONS

Prerequisites

SEL 32 Series Computer

References

Technical Manual 325-329008

Physical/ Environmental	Dimensions	15 in. x 18 in. (plug-in board)
	Weight	4 lb
	SEL Bus Slot Requirements	2 slots
	SEL Bus Electrical Load	1 load
	Power Requirements	Provided by CPU Chassis
	Temperature	10°C - 40°C
	Humidity	5% - 95% Relative
	Maximum Cable Length to Cartridge Disc Formatter	30 ft.
Performance	Maximum Thruput	312K bytes/sec
	Number of Formatters/Cont.	1
	Disc Drives/Cont.	4
	Compatible Cartridge Disc Drives	Model 9306-5M byte Model 9308-10M byte

MOVING HEAD DISC CONTROLLER MODEL 9010

DESCRIPTION

The Model 9010 Moving Head Disc Controller, which features error detection/correction, can transfer data at a rate of 1.2M bytes per second between four moving-head disc drives and an SEL 32 Series Computer. The Model 9010 is on a single plug-in board and plugs directly into the SEL Bus. It consists of three parts: the SEL Bus interface, a Microprogrammable Processor (MP), and a moving head disc interface.

The SEL Bus interface provides logic circuits, staging registers, and drivers to allow the MP to communicate with the CPU and memory over the SEL Bus. Switches, which may be changed to suit individual system requirements, determine the SEL Bus priority level and IOM address. A 32-bit register provides buffering of input data from the SEL Bus so that the SEL Bus is not slowed due to a temporarily busy device.

The MP in the Model 9010 Moving Head Disc Controller performs logical, control, and arithmetic functions. It features a microprogrammed ROM control memory and it includes an ALU, two 16-bit by 16-word register stacks, and order structure logic for generating external control signals.

Through the execution of a single instruction by the CPU, the Model 9010 can be conditioned to transfer a complete block of data between memory and a moving head disc. The Moving Head Disc Controller then takes charge of the I/O operation, and the CPU is freed to perform other tasks. Upon termination of the block transfer, the Model 9010 generates an interrupt which is recognized by the CPU. Having received the interrupt, the CPU initiates a query to the controller, resulting in status transfer. This transfer informs the CPU whether the transfer was successful, or what errors were encountered.

A serial-to-parallel/parallel-to-serial converter in the controller's device interface terminates a high-speed serial data link to the disc drives. This link operates at 9167 MHz to provide a data transfer rate of 1.2M bytes per second.

Up to four disc drives, either 40M byte or 80M byte, can be daisy-chained up to 50 feet on the serial link.

The Moving Head Disc Controller can correct and detect errors caused by disc pack imperfections. Each sector read is core-buffered, and an Error Correction Code (ECC) is generated based on nth degree polynomials. Errors consisting of up to seven sequential bits are corrected, while errors consisting of up to nine sequential bits are detected with 100% probability. Random errors and sequential errors exceeding nine bits have a very high probability of being detected. Since the Controller itself is in charge of detecting and correcting errors, CPU intervention is necessary only for checking status flags.

HIGHLIGHTS

- Error Detection/Correction
- 1.2M Bytes/Sec Transfer Rate
- 4 Disc Drives/Controller

SPECIFICATIONS

Prerequisites: SEL 32 Computer

References: Technical Manual 325-329010

Physical/ Environmental	Dimensions	15 in. x 18 in. (plug-in board)
	Weight	3 lb
	SEL Bus Slot Requirements	2 slots
	SEL Bus Electrical Load	1 load
	Power Requirements	Provided by CPU Chassis
	Temperature	10°C - 40°C
	Humidity	5% - 95% Relative
	Maximum Cable Length to Moving Head Disc Drives	50 ft (total daisy chain)
Performance	Maximum Thruput	1.2 bytes/sec (9.67 MHz)
	Bytes/Sector	768
	Sectors/Track	23
	Bits/Inch	6038
	Error Detection/ Correction	9 bits/sector detection 7 bits/sector correction
	Disc Drives/Controller	4 (max)
	Compatible Moving Head Disc Drives	Model 9320 - 80M byte Model 9321 - 40M byte

MAGNETIC TAPE CONTROLLER MODEL 9012

DESCRIPTION

The Model 9012 Magnetic Tape Controller is a standard SEL 32 Input/Output Microprogrammable Processing (IOM). It is on a single plug-in module, and provides an interface between a SEL 32 Series Computer and any of three tape formatters. Functionally, the Magnetic Tape Controller consists of three parts: a standard SEL Bus interface, a microprogrammable processor, and a tape formatter interface.

The SEL Bus interface includes drivers and receivers for data and control lines on the SEL Bus, a 32-bit buffer register, and a toggle switch for electrically disconnecting the Magnetic Tape Control Unit from the SEL Bus.

The microprogrammable processor, which includes a ROM, has firmware to permit it to respond to Command Device (CD) and Test Device (TD) instructions from the CPU for the Magnetic Tape System. Upon execution of a single CD instruction, the controller can be conditioned to transfer a block of data between a selected magnetic tape unit and memory. Once the block transfer is initialized, the magnetic tape control unit takes charge of the I/O operation, and the CPU is freed to perform other tasks.

When a block transfer is completed, the controller signals the CPU by an interrupt. The CPU can then execute a TD instruction to determine whether the transfer was successful and, if not, what errors were encountered.

The tape formatter interface consists of drivers and receivers to match signal levels between the controller and any of three tape formatters; i.e., Model 9350 7/9-Track NRZI Formatter, Model 9351 9-Track Phase Encoded Formatter, or Model 9352 9-Track NRZI/Phase Encoded Formatter.

HIGHLIGHTS

- 7/9 - Track
- 556/800/1600 bpi
- NRZI/PE

SPECIFICATIONS

Prerequisites: SEL 32 Series Computer

References: Technical Manual 325-329012

Physical/ Environmental

Dimensions	15 in. x 18 in. (plug-in board)
Weight	3 lb
SEL Bus Slot Requirements	2 slots
SEL Bus Electrical Load	1 load
Power Requirements	Probided by CPU Chassis
Temperature	10°C - 40°C
Humidity	5% - 95% Relative
Maximum Cable Length to Mag Tape Formatter	30 ft

Performance	Maximum Thruput	1,600 characters/inch 120,000 characters/sec at 75 ips 200,000 characters/sec at 125 ips
	Number Formatters/Controller	1
	Tape Speed	45/75 ips
	Number of Tracks	7/9
	Recording Method	NRZI and PE
	Density	556, 800, 1600 bpi

FIXED HEAD DISC CONTROLLER MODEL 9014

DESCRIPTION

The Model 9014 Fixed Head Disc Controller is designed for use in applications requiring rapid access and high-speed data transfer.

The Model 9014 Fixed Head Disc Controller provides control for two Fixed Head Discs or two (two port by four drive) multiplexers.

HIGHLIGHTS

- Maximum Transfer Rate 1.1 Megabytes

SPECIFICATIONS

Prerequisites

SEL 32 Series Computer

References

Technical Manual 325-329014

Physical/ Environmental

Dimensions	15 in. x 17.9 in. (plug-in-board)
Weight	4 lb
Power Requirements	Provided by SEL Bus
SEL Bus Slot Requirement	2 slots
SEL Bus Electrical Load	1 load
Temperature	10°C - 40°C
Humidity	5% - 95% Relative
Maximum Cable Length to Fixed Head Disc	30 ft

GENERAL PURPOSE INPUT/OUTPUT MODULE MODEL 9102

DESCRIPTION

The Model 9102 General Purpose Input/Output (GPIO) module is an Input/Output Microprogrammable Processor without a set of firmware or device dependent logic. The customer must design the supporting firmware and the device dependent logic to make the GPIO operate as an I/O Controller for some specific type of I/O device.

The Model 9102 GPIO is the base for most of the standard SEL 32 peripheral controllers. The Model 9102 GPIO may also be used to interface to non-standard devices with transfer rates up to 1.2M bytes per second.

The GPIO consists of three functional parts: a SEL Bus interface, a Microprogrammable Processor (MP), and some device dependent interface logic. For the most part, the device interface logic will consist of drivers and receivers for matching signal levels with the external device(s). Except for the device interface and the firmware which is implanted in the control memory of MP, all GPIO's are identical.

The GPIO allows I/O operations in the SEL 32 Computers to be handled quickly and efficiently through the use of the GPIO, an intelligent I/O controller. Because the GPIO is a processor in its own right, it can handle I/O operations with a minimum amount of CPU intervention.

Through the execution of a single instruction by the CPU, an GPIO can be conditioned to transfer an entire block of data between memory and an external device. When the block transfer is completed, the GPIO signals the CPU with a Service Interrupt (SI).

The GPIO is on a single 15-inch wide by 18-inch deep plug-in circuit board. A row of connector pins, which runs the full width of the board, provides the electrical interface to the SEL Bus and to the external device(s). These pins are segmented into three groups: 184 pins in the middle for the SEL Bus, and two groups of 50 pins each toward the sides for the external device connections. Four smaller sets of connector pins on the opposite end of the board are provided for test purposes.

A small toggle switch on the GPIO, which is accessable to operations and maintenance personnel, provides a means for electrically disconnecting the GPIO from the SEL Bus without removing the board from the chassis. Two other sets of switches provide for setting the GPIO SEL Bus priority and address.

HIGHLIGHTS

- Intelligent I/O Controllers - relieve the CPU of I/O control functions
- Fast Thruput - approximately 1.2M bytes per second.
- Commonality of Hardware - fewer spare parts
- Single Plug-In Board
- Off-the-Shelf TTL, LSI/MSI Components
- On-Line/Off-Line Switch
- Jumper Selectable SEL Bus Priority and IOM Address

SPECIFICATIONS

Prerequisites: SEL 32 Series Computer

References: Technical Manual 325-329000

PHYSICAL/ ENVIRONMENTAL	Dimensions	15 in. x 18 in. (plug-in board)
	Weight	4 lb
	SEL Bus Slot Requirements	2 slots
	SEL Bus Electrical Load	1 load
PERFORMANCE	Working Registers	32 total
	RA Group	16 registers, 16 bits each
	RB Group	16 registers, 16 bits each
	Data/Address Outputs (To Ext. Device)	
	RA Group	16 bits
	RB Group	16 bits
	Total	32 bits
	Data/Address Inputs (From Ext. Device)	
	B MUX	16 bits
	Order Outputs	

	Latched Orders	Pulsed Orders	Totals
SEL Bus Orders	3	8	11
External Orders	13	7	20
Branch Orders	0	1	1
Totals	16	16	32

Pulse Width	75 nsec
Pulse Start	87 nsec after command cycle
Pulse Stop	12 nsec after start of next cycle
Test Inputs	48 total
SEL Bus Test Inputs	32
External Device Test Inputs	16
IOM Thruput (max)	1.2M bytes/sec (approx.) for 32-bit transfers
Word Sizes	
Data Word	16/32 bits
Microcommand Word	32 bits
Control Memory	
Capacity Implemented	1024 words (32-bit)
Cycle Time	150 nsec

GENERAL PURPOSE MULTIPLEXER CONTROLLER MODEL 9104

DESCRIPTION

The Model 9104 General Purpose Multiplexer Controller (GPMC) is a Multiplexer Channel Input/Output Microprogrammable Processor (IOM) for the SEL 32 Series Computers, which provides an Input/Output (I/O) link between the SEL 32 Series Computer and up to 16 I/O channels. A channel or a subchannel is typically connected to a slow-to-medium speed peripheral device. The GPMC which is on a single plug-in module, provides I/O control for the various input/output channels.

The GPMC consists of three functional blocks and plugs directly into the SEL Bus. The three functional blocks are: the SEL Bus interface, a Microprogrammable Processor, and a multiplexer.

The SEL Bus interface includes drivers and receivers for data and control lines on the SEL Bus, a 32-bit buffer register, and a toggle switch for electrically disconnecting the GPMC from the SEL Bus.

The firmware in the Microprogrammable Processor has been implemented to respond to the SEL 32 Series Computer's I/O instructions, the Command Device (CD) and the Test Device (TD) instruction.

Through the execution of a single CD instruction by the CPU, any one of the available multiplexer channels or subchannels can be conditioned for a block transfer. Once the block transfer has been initialized, the GPMC takes full control over the operation, and the CPU is free to perform other tasks.

When the block transfer is completed, the GPMC signals the CPU by an interrupt. The CPU can then execute a TD instruction to determine whether the transfer was successful and, if not, what errors were encountered.

HIGHLIGHTS

- 150K Byte or Halfword Transfer Rate
- 16 I/O Channels, 16 subchannels per channel

SPECIFICATIONS

Prerequisites: SEL 32 Computer

References: Technical Manual 325-329104

Physical/ Environmental

Dimensions	15 in. x 17.9 in. (plug-in board)
Weight	4 lbs
SEL Bus Slot Requirement	2 slots
SEL Bus Electrical Load	1 load
Power Requirements	Provided by SEL Bus
Temperature	$10^{o}C$ - $40^{o}C$
Humidity	5% - 95% Relative

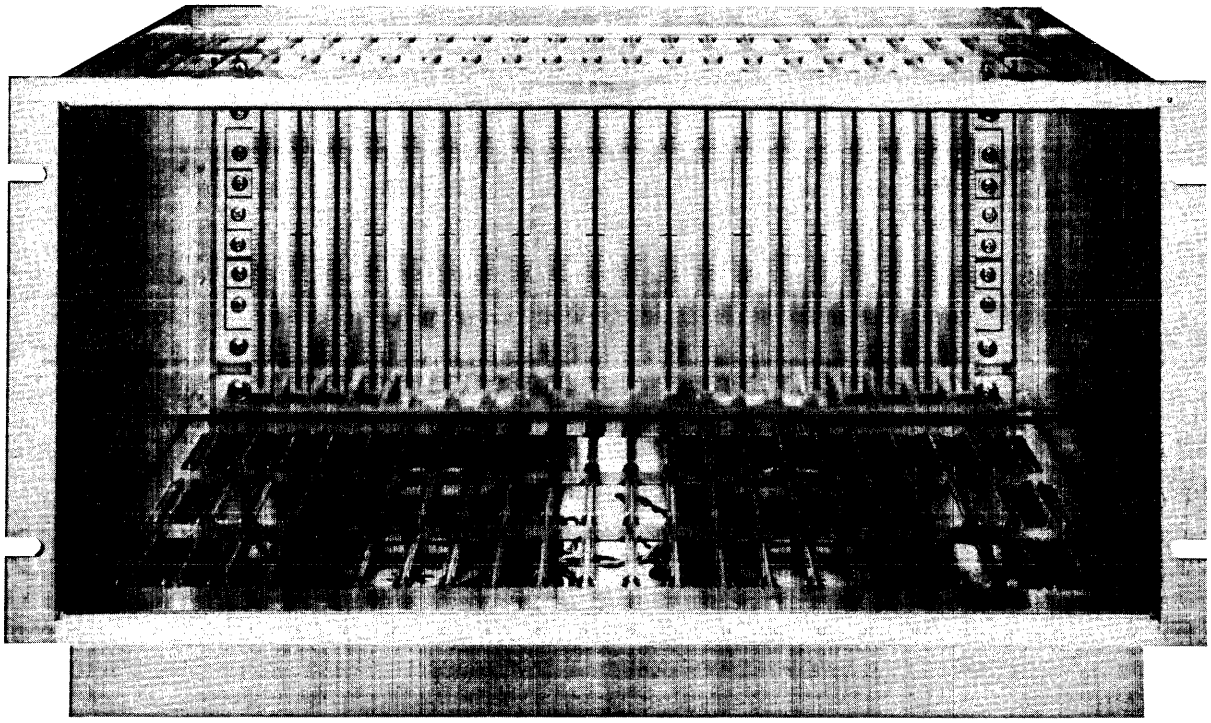
Performance — IOM

Word Sizes	
Data Word	16/32 bits
Microcommand Word	32 bits
Control Memory	
Capacity (max)	4096 Words (32-bit)
Capacity Implemented	1024 Words (32-bit)
Cycle Time	150 nsec
IOM Thruput (max)	1.2M bytes/sec (approx.) for 32-bit transfers
Working Registers	32 total
RA Group	16 Reg., 16 bits each
RB Group	16 Reg., 16 bits each
Data/Address Outputs (To Ext. Device)	
RA Group	16 bits
RB Group	16 bits
Total	32 bits
Data/Address Inputs (From Ext. Device)	
B MUX	16 bits

Order Outputs

	Latched Orders	Pulsed Orders	Totals
SEL Bus Orders	2	7	9
External Orders	14	8	22
Branch Orders	0	1	1
Totals	16	16	32

Pulse Width	75 nsec
Pulse Start	87 nsec after command cycle
Pulse Stop	12 nsec after start of next cycle



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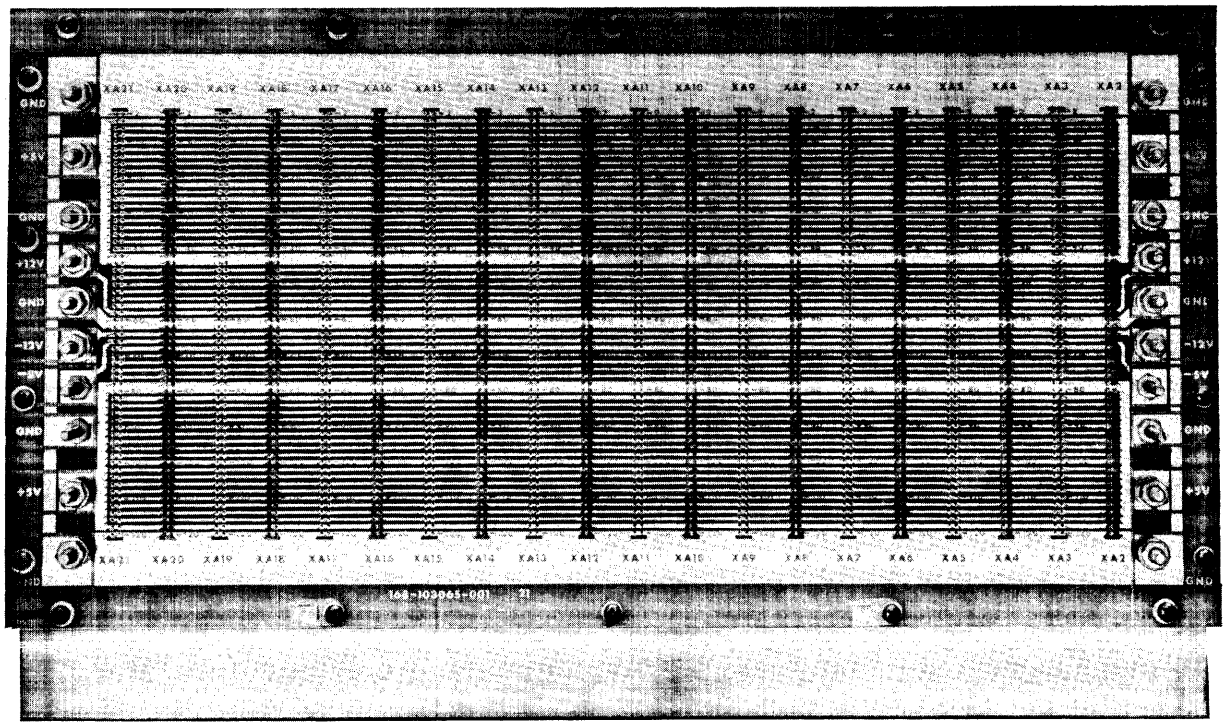
FRONT VIEW



REAR VIEW

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General Purpose Device Controller Chassis Model 9105

GENERAL PURPOSE DEVICE CONTROLLER CHASSIS MODEL 9105

DESCRIPTION

The Model 9105 General Purpose Device Controller chassis provides slots for up to 16 Model 9106 General Purpose Device Controller cards. The chassis consists of a 19-inch rack mount card cage and fan assembly. A 25-foot interface cable is provided for interfacing the GPDC controller cards to the Model 9104 General Purpose Multiplexer Controller.

A separate power supply provides voltages of +5 Vdc, +12 Vdc, and -12 Vdc to the backplane of the GPDC chassis.

Note

The Model 9105-1 GPDC Chassis is the same as the Model 9105 except the chassis is wired for 220 Vac, 50 Hz power

HIGHLIGHTS

- Mounts in standard 19-inch EIA rack

SPECIFICATIONS

Prerequisites

General Purpose Multiplexer Controller Model 9104
General Purpose Device Controller Model 9106

References

Technical Manual 325-329104
Technical Manual 325-329106

Physical/ Environmental

Dimensions

Height	10.5 in.
Width	19 in.
Depth	12.5 in.

GENERAL PURPOSE DEVICE CONTROLLER MODEL 9106

DESCRIPTION

The Model 9106 General Purpose Device Controller (GPDC) provides an 8 or 16-bit parallel interface to a slow-to-medium speed peripheral device or special user equipment.

The GPDC is on a single plug-in module, consists of three functional blocks, and plugs into a card slot (1 of 16) provided by the Model 9105 GPDC chassis. The three functional blocks are: the GPDC Bus interface, the Microprogrammable Control Logic, and the device dependent logic.

The GPDC Bus interface is primarily driven by the Model 9104 GPMC and allows up to 16 GPDC's to be connected to the GPDC bus.

The Microprogrammable Control Logic provides sequencing and control for orders and data between the customer's device dependent logic and the GPDC Bus interface.

HIGHLIGHTS

- Up to 120K Block data transfers (16-Bit Transfer Per Second)
- 8 or 16-Bit Wide Data Paths to Customer Device
- Up to 65,536 Transfers Per Block

SPECIFICATIONS

Prerequisites

General Purpose Multiplexer Controller, Model 9104
General Purpose Device Controller Chassis, Model 9105

References

Technical Manual 325-329106

Physical/ Environmental

Dimensions	15 in. x 18 in. (plug-in board)
Weight	3 lb
Power Requirements	+5V @ 4.5 amps +12V @ 4 amps -12V @ 4 amps
Temperature	10°C - 40°C
Humidity	5% - 95% Relative

CARD PUNCH CONTROLLER MODEL 9107

DESCRIPTION

The Model 9107 Card Punch Controller (CPC) provides a 16-bit parallel interface to the Model 9219 Card Punch. The CPC is on a single 8.65 in. x 12.50 in. plug-in board and plugs into a card slot provided by the Model 9105 General Purpose Device Controller Chassis.

The CPC consists of three functional blocks and plugs directly into the GPDC bus. The three functional blocks are: the GPDC Bus interface, the Microprogrammable Control Logic, and the Card Punch interface (device dependent logic).

The GPDC Bus interface is primarily driven by the Model 9104 GPMC which provides most of the control functions for the CPC.

The Microprogrammable Control Logic provides sequencing and control for orders and data between the GPDC Bus Interface and the Card Punch interface.

The CPC Interface Logic provides the circuitry to output commands/orders from the Microprogrammable Control Logic to the Card Punch, or input status from the Card Punch to the Microprogrammable Control Logic.

HIGHLIGHTS

- Data Transfer Rate - 160 Bytes/second between GPMC and CPC
- 12-Bit Data Path - UASCII Card Code or Packed Binary to Punch

SPECIFICATIONS

Prerequisites

Model 9104 General Purpose Multiplexer
Model 9105 General Purpose Device Controller Chassis

References

Technical Manual 325-329107

Physical/ Environmental

Dimensions	8.65 in. x 12.5 in. (plug-in board)
Weight	1.375 lb
Power Requirements	+5 Vdc provided by GPDC Power Supply

Performance

Data Transfer Rate	160 bytes/second between the GPMC and CPC

ASYNCHRONOUS DATA SET INTERFACE MODEL 9122

DESCRIPTION

The Model 9122 Asynchronous Data Set Interface (ADS) provides four half or full duplex Asynchronous RS232C channels for connecting data communications equipment and terminals to the SEL 32 Series Computers.

The basic ADS operates at rates of 50 to 9600 baud and is fully programmable on an individual channel basis.

The ADS is implemented on a standard SEL 32 IOM (Input/Output Microprogrammable Processor) and includes a SEL Bus interface, a Microprogrammable Processor with ADS firmware, and four full duplex communications channel interfaces.

Two options are available to improve and extend the capability of the Model 9122 ADS. These options are Current Loop Option, Model 9122-10, and a PLO/High Rate Select Option, Model 9122-12.

The Current Loop Option provides an adapter board with four RS232C-to-Current Loop Converters. This option allows any or all channels to be used with any 20 MA Teletype compatible terminal.

The PLO/High Rate Select Option provides a phase lock oscillator for synchronizing the 110 baud rate with the 50/60 Az line frequency. It also provides hardware selection (jumpers) 14.4K, 19.2K, 28.8K, or 38.4K baud internal rates, or an external rate up to 40K baud.

An ADS Diagnostic Kit Model 9122-11, plugs into the edge connector on the ADS, is available as an option for maintenance and test purposes. The ADS Diagnostic Kit features LED displays and facilities for loopback.

HIGHLIGHTS

- Baud Rate Selection
- Parity Generation and Selection
- Frame Size Selection
- Stop Bit Selection
- Mode Selection
- Interrupt Mode Selection
- Automatic Storage of Status in a program specified location
- Standard Block Mode Transfers
- Program Selectable start, delete, and interrupt characters
- Double Character Buffering
- Auto Answer
- Echoplex (Enforced Half Duplex)
- Up to four special characters per channel may be specified for detection and interrrupt generation

SPECIFICATIONS

Prerequisites — SEL 32 Series Computer

References — Technical Manual 325-329122

PHYSICAL/ ENVIRONMENTAL	Dimensions	15 in. x 18 in. (plug-in board)
	Weight	3 lb
	SEL Bus Requirements	2 slots
	Power Requirements	Provided by CPU Chassis
Performance	• Number of Channels	4 Full Duplex, or 4 Half Duplex, or 8 Enforced Half Duplex, or 8 Simplex RX and 8 Simplex TX
	• Channel Addresses	Primary Receive Addresses (even) Primary Transmit Addresses (odd) Secondary Receive Addresses (odd) Secondary Transmit Addresses (even)
	• Baud Rate Selection	Fifteen internal Rates from 50 to 9,600 baud are available on the basic ADS. When the Model 9122-12 option is included, any one of four internal high rates (14.4K, 28.8K, 19.2K, or 38.8K) or an external rate up to 40K baud can be selected.

Bits				Baud Rate
8	9	10	11	
0	0	0	0	External*
0	0	0	1	50
0	0	1	0	75
0	0	1	1	110
0	1	0	0	134.5
0	1	0	1	150
0	1	1	0	300
0	1	1	1	600
1	0	0	0	900
1	0	0	1	1200
1	0	1	0	1800
1	0	1	1	2400
1	1	0	0	3600
1	1	0	1	4800
1	1	1	0	7200
1	1	1	1	9600

*External clock must be 16 times the desired baud rate or may be a hardware programmable option of 14.4K, 19.2K, 28.8K, 38.4K baud or 110 baud phase locked to the line frequency of 50/50 Hz ± 5%.

- Parity Generation and and Selection - Odd, even, or no parity generation and selection is provided on the ADS.
- Frame Size Selection - Frame sizes of either 5, 6, 7, or 8 bits are program selectable on the ADS.
- Stop Bit Selection - A choice of either one or two stop bits is provided by the ADS.

Performance (Cont'd)

- Mode Selection - Programmable Mode Selection provides a choice of full duplex or half duplex modes. Enforced half duplex is selected through channel address assignments.
- Interrupt Mode Selection - The ADS can be programmed to generate an interrupt or any of the following conditions:
  - Zero byte count
  - Zero byte count or combinations of selectable characters
  - Program selectable Ring characters
  - Remote station Ring defect

HIGH SPEED DATA INTERFACE MODEL 9132

DESCRIPTION

The Model 9132 High Speed Data interface (HSD) provides a full 32-bit parallel interface to a customer device at rates up to 834K transfers per second. The HSD is on a single plug-in module and plugs directly into the SEL bus.

The HSD consists of three functional blocks: the SEL Bus interface, control logic and storage registers, and the customer handshake interface.

The HSD has a dual SEL Bus interface consisting of independent sets of destination and data registers for the CPU and memory. This arrangement allows overlapped CPU and memory communications to and from the HSD.

The control logic consists of two PROM control sequencers that provide all control functions internal to the HSD, as well as the SEL Bus and customer interface.

The customer handshake interface consists of 32 bidirectional data bus drivers and receivers, handshake control logic, and a data staging register. Appropri- handshake control signals are generated to interface the HSD to a customer designed device interface.

HIGHLIGHTS

- 834K Words/Sec Transfer Rate
- 32-Bit Data Path
- Up to 64K Transfers per Block
- External Mode Capability
- Command and Data Chaining
- Automatic Status Posting
- Intercomputer Link Capability

SPECIFICATIONS

Prerequisites

SEL 32 Series Computer

References

Technical Manual 325-329132

Physical/ Environmental

Dimensions	15 in. x 18 in. (plug-in board)
Weight	4 lb
SEL Bus Slot Requirements	2 slots
SEL Bus Electrical Load	1 load
Power Requirements	Provided by SEL Bus
Temperature	10°C - 40°C
Humidity	5% - 95% Relative

SERIAL DATA INTERFACE MODEL 9134

DESCRIPTION

The Model 9134 Serial Data Interface (SDI) consists of a basic IOM with device dependent logic consisting of an 8586 compatible Serial Link Interface. The Serial Data Interface enables the SEL 32 Computer to operate all SYSTEMS 85/86 Serial Link Controllers with a maximum data frame rate of 200 KHz. The SDI is on a single plug-in module and plugs directly into the SEL Bus.

The SDI consists of three functional blocks: The SEL Bus interface, a microprogrammable processor, and device dependent logic.

The SEL Bus interface includes drivers and receivers for data and control lines on the SEL bus, a 32-bit buffer register and a toggle switch for disabling the SDI from the SEL Bus.

The firmware in the microprogrammable processor has been implemented to respond to the SEL 32 Series Computer's I/O instructions: the Command Device (CD) and the Test Device (TD) instruction.

Through the execution of a single CD instruction by the CPU, the SDI is conditioned for a block transfer. Once the block transfer has been initialized, the SDI takes full control over the operation, and the CPU is free to perform additional tasks.

When the block transfer is completed, the SDI signals the CPU by an interrupt. The CPU can then execute a Test Device (TD) instruction to determine whether the block transfer was successful and, if not, what errors occurred.

HIGHLIGHTS

- 200K Byte or Halfword Transfer Rate

SPECIFICATIONS

Prerequisites

SEL 32 Computer

References

Technical Manual 325-329134

PHYSICAL/ ENVIRONMENTAL

Dimensions	15 in. x 17.9 in. (plug-in board)
Weight	3 lb
SEL Bus Slot Requirements	2 slots
SEL Bus Electrical Load	1 load
Power Requirements	Provided by SEL Bus
Temperature	10°C - 40°C
Humidity	5% - 95% Relative

Performance

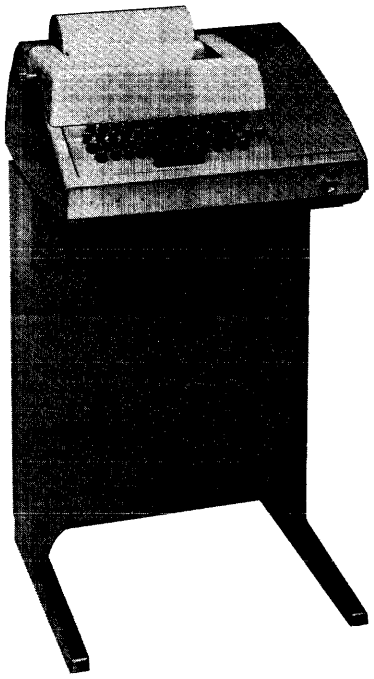
IOM

Word Sizes	
Data Word	16/32 bits
Microcommand Word	32 bits
Control Memory	
Capacity (max)	4096 Words (32-bit)
Capacity Implemented	1024 Words (32-bit)
Cycle Time	150 nsec

Performance (Cont'd)	IOM Thruput (max)	1.2M bytes/sec (approx.) for 32-bit transfers
	Working Registers	32 total
	RA Group	16 Reg., 16 bits each
	RB Group	16 Reg., 16 bits each
	Data/Address Outputs (To Ext. Device)	
	RA Group	16 bits
	RB Group	16 bits
	Total	32 bits
	Data/Address Inputs (From Ext. Device)	
	B MUX	16 bits
	Order Outputs	

	Latched Orders	Pulsed Orders	Totals
SEL Bus Orders	2	7	9
External Orders	14	8	22
Branch Orders	0	1	1
Totals	16	16	32

Pulse Width	75 nsec
Pulse Start	87 nsec
Pulse Stop	12 nsec after start of next cycle



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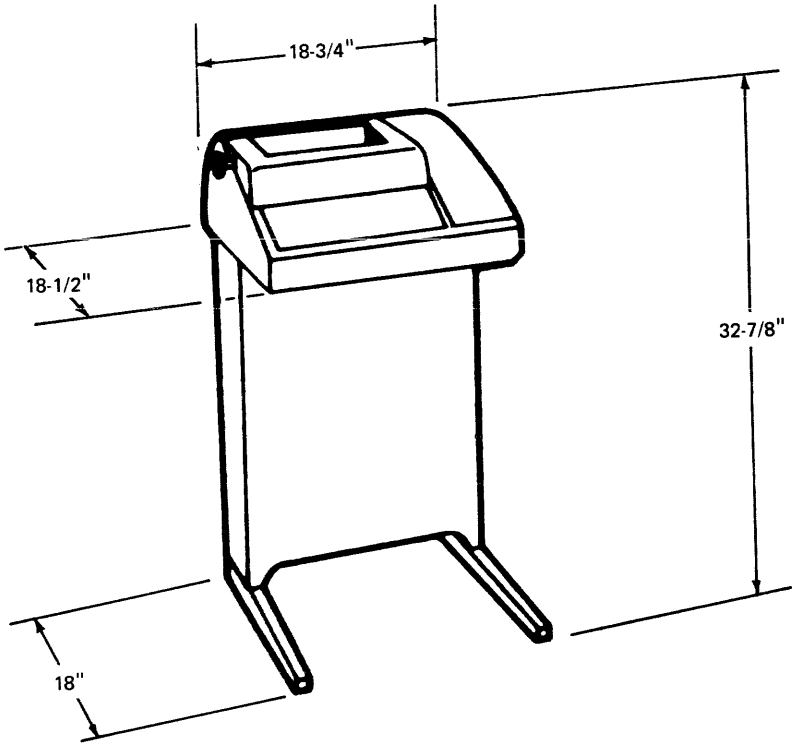


KSR-33 Teletypewriter Model 9201

KSR-33 TELETYPEWRITER MODEL 9201

DESCRIPTION

The Model 9201 Console Teletypewriter offers users of SEL 32 Series Computers one means of conducting local communications with the central processor. Operating at a data transfer rate of 10 characters per second with ASCII code, the Model 9201 is ideal for handling low volumes of input/output data, file interrogations, minor program alterations, and testing. Users can readily verify transmission accuracy because a program-controlled character turn-around feature sends a duplicate of the data received by the computer back to the page printer.

HIGHLIGHTS

- 10 Charcters/Sec
- Standard ASCII Code
- 72 Characters/Line

SPECIFICATIONS

Prerequisites

Teletype channel in Model 9004 TLC Controller.

References

Technical Manual - Teletype Bulletin 310B/Volumes 1 and 2
Parts Manual - Teletype Bulletin 1184B
Wiring Diagrams Manual - Teletype WDP 0316
Reference Manual 324-886310
Technical Manual 325-329004

PHYSICAL/ ENVIRONMENTAL

Height	32.875 in.
Width	18.750 in.
Depth	18.500 in.
Operating Temperature	5°C - 43°C
Relative Humidity	30% - 90% (non-condensing)
Power Requirements	
Voltage	115 Vac ±10%
Frequency	60 Hz ±3/4%
Current	1.9A
Heat Dissipation	1176 Btu/hr
Maximum Cable Length to TLC Controller	30 ft

Performance

Page Printer	
Printing Speed	10 characters/sec
Characters/line	72
Input Code	Standard ASCII
Character Set	Letters A through Z, numbers 0 through 9, and 28 commonly used symbols and punctuation marks.

Performance (Cont'd)

Keyboard:

Transfer Speed	10 characters/sec
Output	Standard ASCII
Character Set	Letters A through Z, numbers 0 through 9, and 28 commonly used symbols.

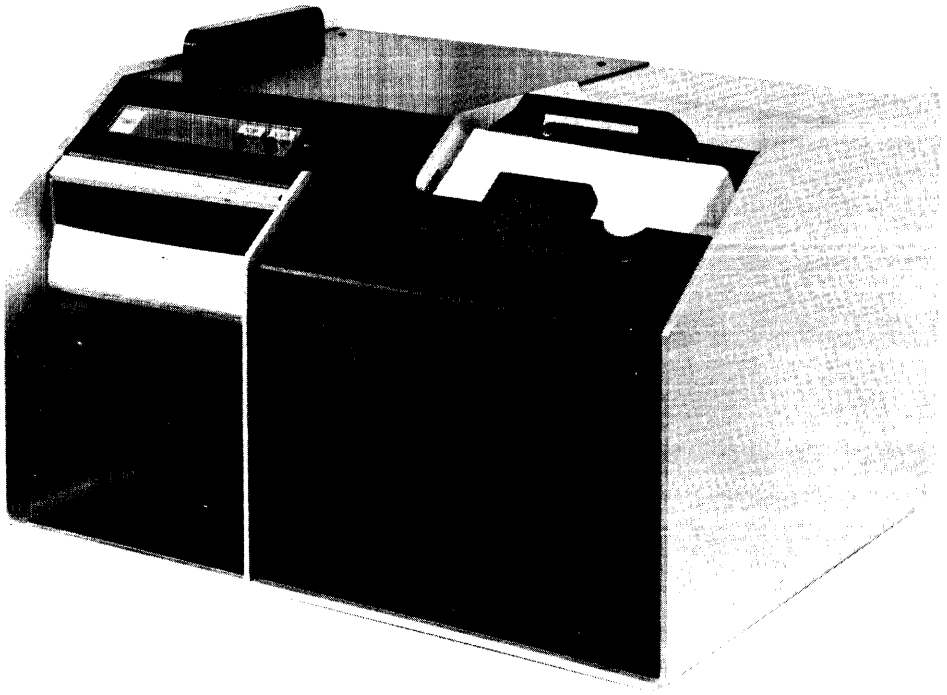
Cable, AC Power

Model 9201 (115V, 60 Hz)

Plug	Hubble 5921, NEMA Configuration 5-15P
Receptical	Hubble 5262, NEMA Configuration 5-15R
Length	8 ft

Model 9201-1 (115V, 50 Hz)

Power cable and connectors same as Model 9201.



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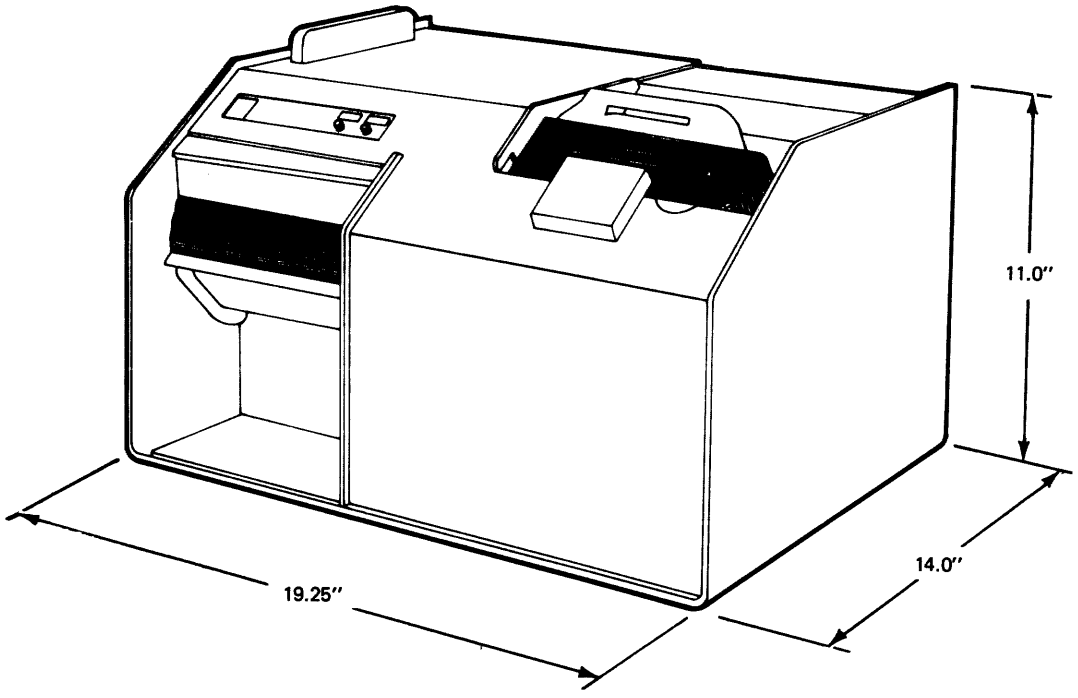


Card Reader Model 9210

CARD READER (300 CPM) MODEL 9210

DESCRIPTION

The Model 9210 card reader has a vacuum picker mechanism that can pick mutilated, warped, and edge-damaged cards. It also will reject stapled cards without damage to the cards.

The card handler features a straight-through card track which permits almost limitless reusability of card decks. This also makes the reader inherently jam resistant, since only one card is in the card track at any time.

Each card reader comes complete with control and timing electronics to provide stable and reliable data readout. The crystal oscillator controlled timing guarantees the inherent accuracy and stability to provide a high tolerance to misregistered cards.

A photo-transistor sensor array reads standard 12-row, 80-column punched cards serially, column-by-column. The control electronics monitors card movement to insure that card damage will not be caused by the reader mechanism.

HIGHLIGHTS

- 300 CPM
- 80-Column Cards

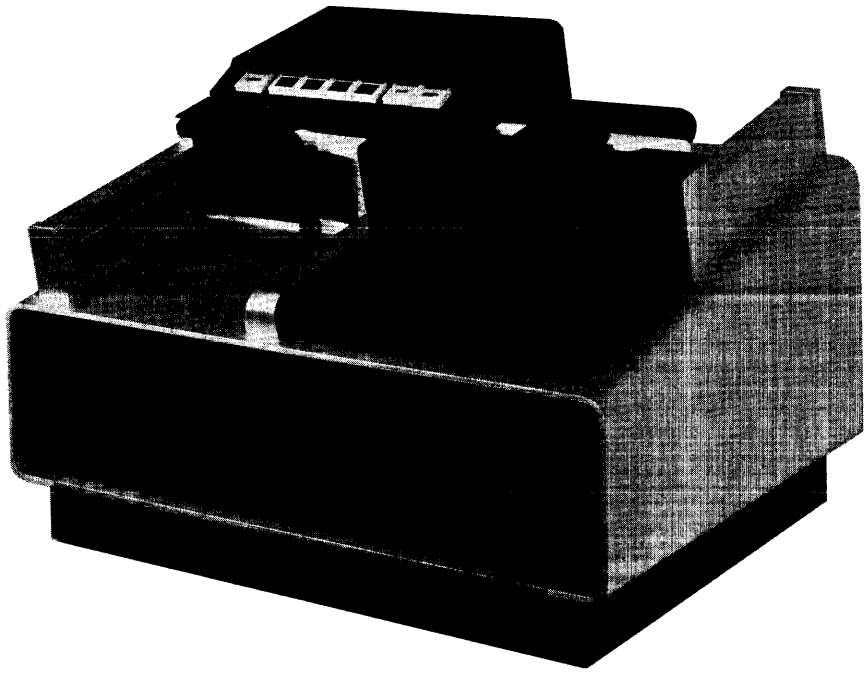
SPECIFICATIONS

Prerequisites: Card Reader Channel in Model 9004 TLC Controller

References: Technical Manual 325-329004
Technical Manual - Documation M-200

Physical/ Environmental	Height	11 in.
	Width	19.25 in.
	Depth	14 in.
	Weight	60 lb
	Power Requirements	
	Voltage	115 Vac ±10%
	Frequency	60 Hz
	Current	14A (starting) 5A (running)
	Heat Dissipation	1780 Btu/hr
	Operating	10°C - 37.8°C
	Relative Humidity	30% - 90% (non-condensing)
	Altitude	1000 ft below sea level - 6000 ft above sea level
	Maximum Cable Length to TLC Controller	30 ft
Performance	Card Rate	300 cpm
	Card Type	Standard 80-column ANSI x 3.11 - 1969

Performance (Cont'd)	Hopper/Stacker	550-card capacity
	Light Source	Infrared light emitting diodes
	Read Station	Photo transistor, 12 bits simultaneously
	Electronics	TTL integrated circuit logic
	Internal Clock	Crystal oscillator
	Cable, AC Power	
	Model 9210 (115V, 60 Hz)	
	Plug	Hubble 5921, NEMA Configuration 5-15P
	Receptical	Hubble 5262, NEMA Configuration 5-15R
	Length	9 ft
	Model 9210-1 (115V, 50 Hz)	
	Power cable and connectors same as Model 9210.	
	Model 9210-2 (230V, 50 Hz)	
	Plug	Hubble 5925, NEMA configuration 6-15P
	Receptical	Hubble 5462, NEMA configuration 6-20R
	Length	9 ft.



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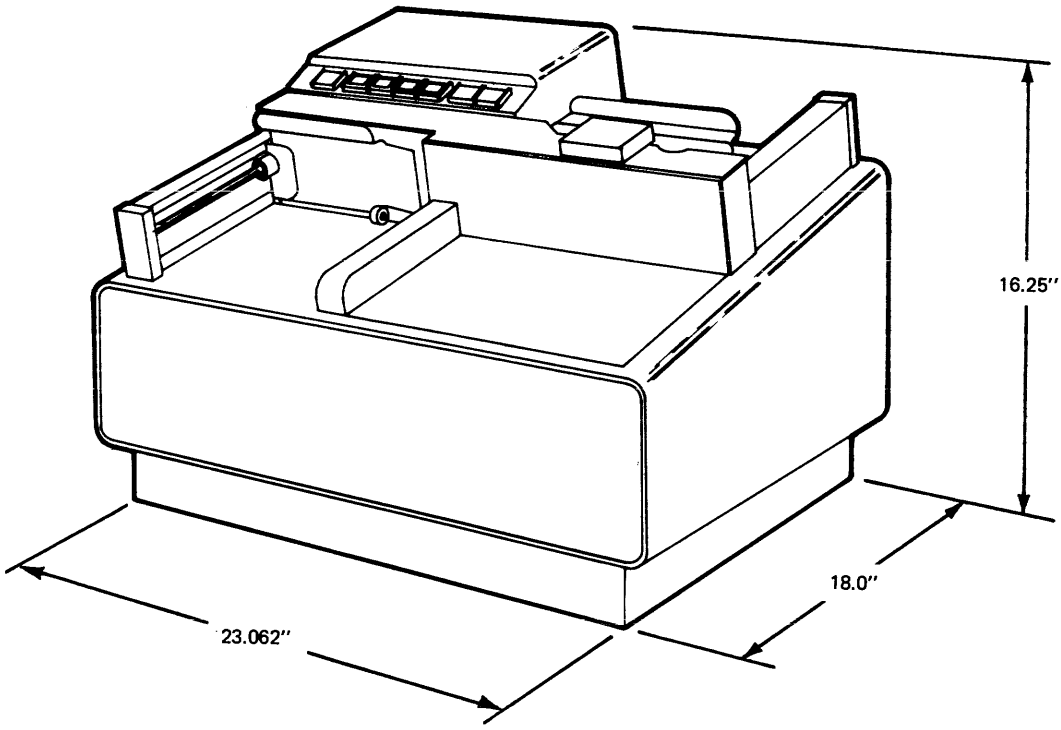


Card Reader Model 9211

CARD READER (1000 CPM) MODEL 9211

DESCRIPTION

The Model 9211 card reader is designed to operate in applications requiring fast and simple loading and unloading and in applications where cards are especially vulnerable to damage through rough handling or adverse environment. The slant top feature permits personnel to load and unload cards while the card reader is operating.

The reader chassis is of heavy duty construction enabling it to withstand continuous operation. The vacuum picker mechansim has a high tolerance to mutilated, warped and edge-damaged cards and will reject stapled cards without damage to the cards.

The card handler features a straight-through card track which permits almost limitless reusability of card decks. This also makes the reader inherently jam resistant, since only one card is in the card track at any time.

Each card reader comes complete with control and timing electronics to provide stable and reliable data readout. The crystal oscillator controlled timing guarantees the inherent accuracy and stability to provide a high tolerance to misregistered cards. A photo-transistor sensor array reads standard 12-row, 80-column punched cards serially, column by column.

HIGHLIGHTS

- 1000 CPM
- 80-Column Cards

SPECIFICATIONS

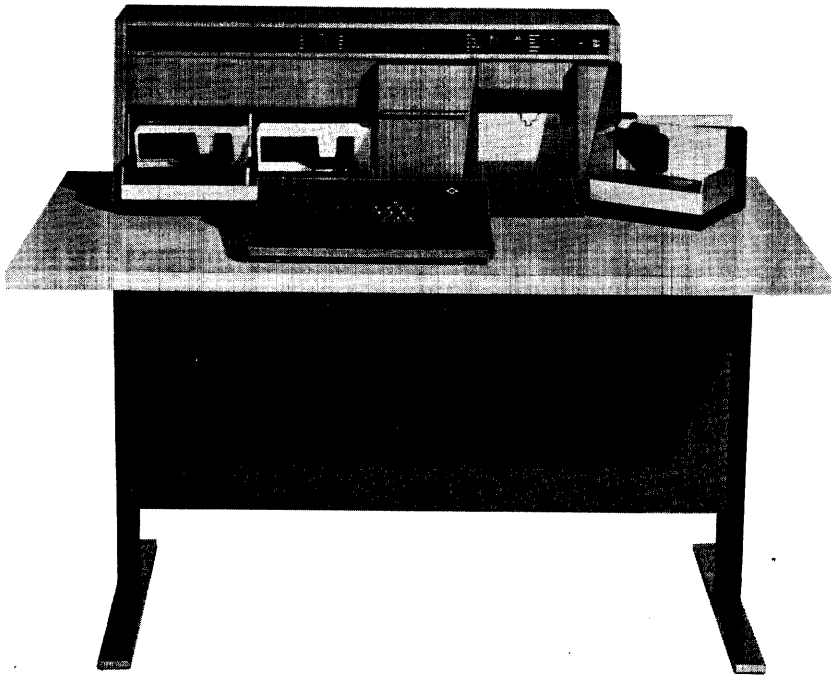
Prerequisites: Card Reader channel in Model 9004 TLC Controller

References:
Technical Manual 325-329004
Technical Manual - Documation M-1000L

Physical/ Environmental

Height	16.25 in.
Width	23.062 in.
Depth	18 in.
Weight	75 lb
Power Requirements	
Voltage	115 Vac ±10%
Frequency	60 Hz
Current	14.3A (starting) 5A (running)
Heat Dissipation	2046 Btu/hr
Operating Temperature	10°C - 36.8°C
Relative Humidity	30% - 90% (non-condensing)
Altitude	1000 ft below sea level - 6000 ft above sea level
Maximum Cable Length to TLC Controller	30 ft

Performance	Card Rate	1000 CPM
	Card Type	Standard 80-column ANSI x 3.11-1969
	Hopper/Stacker	1000-card capacity
	Light Source	Infrared light emitting diodes
	Read Station	Photo transistor, 12 bits parallel
	Electronics	TTL integrated circuit logic
	Internal Clock	Crystal oscillator
	Cable, AC Power	
	Model 9211 (115V, 60Hz)	
	Plug	Hubble 5921, NEMA configuration 5-15P
	Receptical	Hubble 5262, NEMA configuration 5-15R
	Length	9 ft
	Model 9211-1 (115V, 50 Hz)	
	Cable and connectors same as model 9211.	
	Model 9211-2 (230V, 50 Hz)	
	Plug	Hubble 5925, NEMA configuration 6-15P
	Receptical	Hubble 5462, NEMA configuration 6-20R
	Length	9 ft



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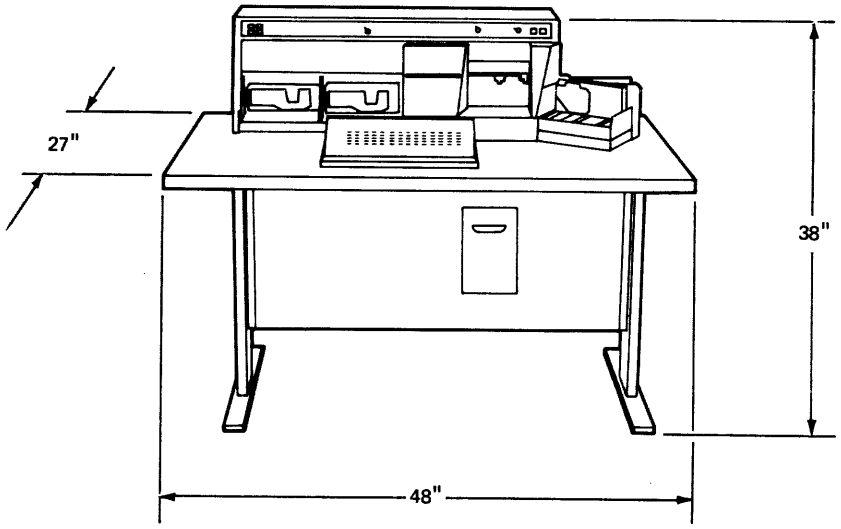


Interpreting Data Recorder Model 9216

INTERPRETING DATA RECORDER MODEL 9216

DESCRIPTION

The Model 9216 Interpreting Data Recorder provides a combination card reader/punch/printer and a data entry keyboard in a single unit for use with the SEL 32 Series Computers. The Model 9216 has indicators for operator efficiency, a movable light touch keyboard, and a fully visible wait station.

In the On-Line Mode, the CPU can control the reading and punch/printing of 80-column cards. In the Off-Line mode, the Model 9216 can be used to manually punch/print cards. Data is keyed into 80-column storage, and is punched and printed on the card when all data has been keyed. Sensed errors are corrected by the operator prior to actual punching and printing.

In the verify mode, errors are corrected by changing stored data. Blank cards are automatically fed from the secondary hopper, punched, notched, and merged in proper sequence. Error cards are automatically selected and stacked separately in the secondary stacker.

The Model 9216 also allows cards to be read into and punched from the wait station; thus, the CPU can accept card data, process it, and punch additional information into the same card.

Other features of the Model 9216 Interpreting Data Recorder include: four program levels; high-speed duplicating and skipping; automatic right justification(right adjust + and -); minimized card cycle dead times; character, field, word, record erase; backspace capability; and two input hoppers and two output stackers.

HIGHLIGHTS

- Card Reader/Punch/Printer
- Keyboard Entry
- On-Line/Off-Line Capability

SPECIFICATIONS

Prerequisites

Models 9108 and Card Reader/Punch Controller

References

Technical Manual 325-329006
Machine Manual - Decision Data 7545
Operators Manual - Decision Data DD-159-114

PHYSICAL/ ENVIRONMENTAL

Height	38 in.
Width	48 in.
Depth	27 in.
Weight	300 lb (approx)
Power Requirements	
Voltage	115 Vac ±10%
Frequency	60 Hz
Current	3.7A
Power	425W
Heat Dissipation	1450 Btu/hr
Operating Temp	5°C - 43°C
Relative Humidity	8% - 90% (non-condensing)
Maximum Cable Length to Card Punch Controller	50 ft

Performance

Speeds

Keyboard Lock Between Cards	30 ms (keypunch) 400 ms (verify)
Keyboard	100 characters/sec
Skip-Duplicate	200 μsec/column
Read	200 cpm
Punch	45 - 75 cpm
Print	45 - 75 cpm

Capacities

Data Storage	400 characters
Program Storage	2,080 bits
Primary Input Hopper	600 cards
Secondary Input Hopper	400 cards
Output Stackers	400 cards (No. 1) 400 cards (No. 2)

Cable, AC Power

Model 9216 (115V, 60 Hz)

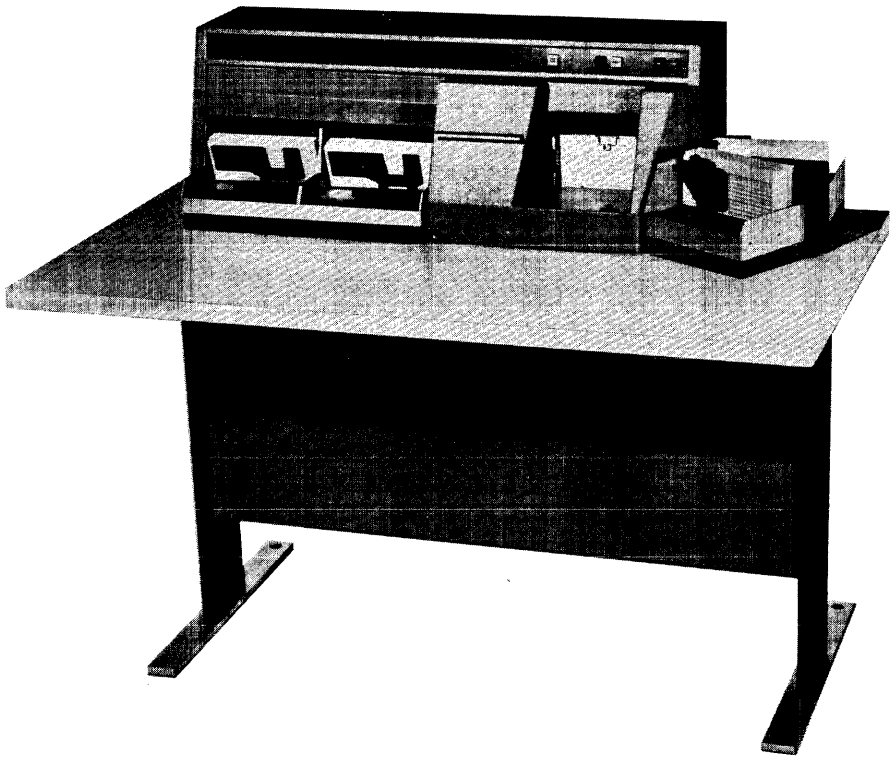
Plug	Hubble 5921, NEMA configuration 5-15P
Receptical	Hubble 5262, NEMA configuration 5-15R
Length	10 ft

Model 9216-1 (115V, 50 Hz)

Cable and connectors same as Model 9216.

Model 9216-2 (230V, 50 Hz)

Plug	Hubble 5925, NEMA configuration 6-15P
Receptical	Hubble 5462, NEMA configuration 6-20R
Length	10 ft



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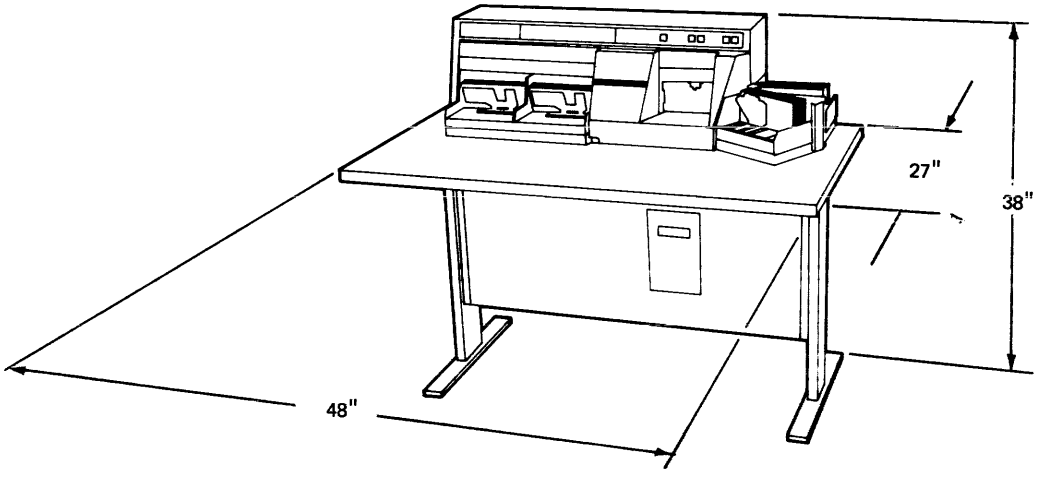


Card Reader/Punch Model 9217

CARD READER/PUNCH MODEL 9217

DESCRIPTION

The Model 9217 is a combination Card Reader/Punch for the SEL 32 Series Computers. This device reads 80-column cards at a rate of 200 cards per minute, and punches at rates from 45 to 75 cards per minute.

Dual input hoppers and output stackers permit reading from one input hopper and punching from the second input hopper while maintaining file separation in the output stackers without operator intervention. All cards to be processed follow a common card path between the input hoppers and output stackers. This path takes each card past a read station, a visible wait station, and a punch station. The primary input hopper has a capacity of 600 cards, and the secondary hopper and both output stackers have capacities of 400 cards each.

A 12-bit structure throughout accomodates any coding application, including binary and packed decimal.

The Model 9217 also allows cards to be read into and punched from the wait station; thus, the CPU can accept card data, process it, and punch additional information into the same card.

For reliability, multi-sensing of all columns assures accurate reading. Design simplicity and mechanism modularity insure ease of service and continuing on-line performance.

HIGHLIGHTS

- 200 CPM Read
- 45-75 CPM Punch
- 80-Column Cards

SPECIFICATION

Prerequisites: Model 9108 Card Reader/Punch Controller

References:
Technical Manual 325-329108
Machine Manual - Decision Data 7545
Operator's Manual - Decision Data DD-159-114

PHYSICAL/ ENVIRONMENTAL

Height	38 in.
Width	48 in.
Depth	27 in.
Weight	300 lb (approx)
Operating Temp.	5°C - 43°C
Relative Humidity	8% - 90% (non-condensing)
Power Requirements	
Voltage	115 Vac ±10%
Frequency	60 Hz
Current	3.7A
Power	425W
Heat Dissipation	1450 Btu/hr

Performance

Speeds

Card Reading	200 cpm
Card Punching (80 columns)	45 - 75 cpm

Capacities

Primary Input Hopper	600 cards
Secondary Input Hopper	400 cards
Output Stackers No. 1	400 cards
No. 2	400 cards

Cable, AC Power

Model 9217 (115V, 60 Hz)

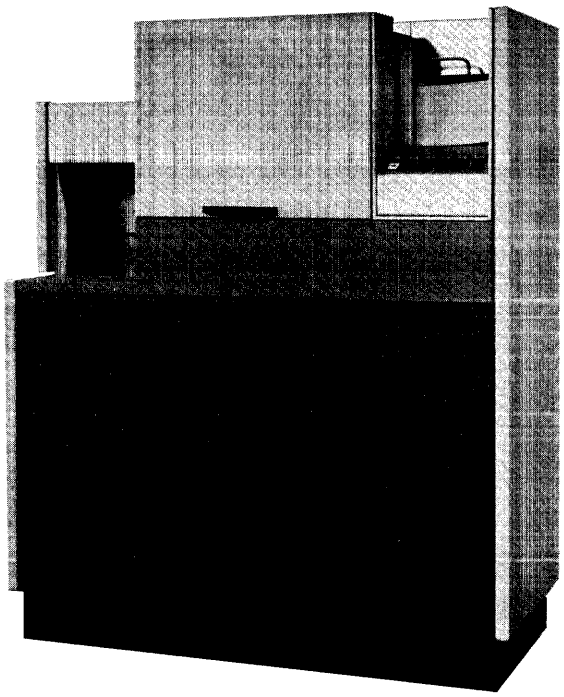
Plug	Hubble 5921, NEMA configuration 5-15P
Receptical	Hubble 5262, NEMA configuration 5-15R
Length	10 ft

Model 9217-1 (115V, 50 Hz)

Cable and connectors same as Model 9217.

Model 9217-2 (230V, 50 Hz)

Plug	Hubble 5925, NEMA configuration 6-15P
Receptical	Hubble 5462, NEMA configuration 6-20R
Length	10 ft



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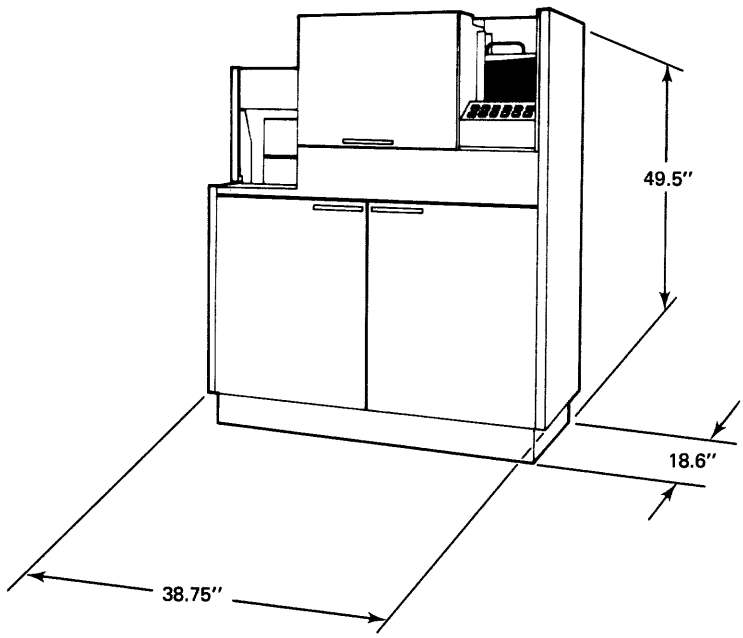


Card Punch Model 9219

CARD PUNCH MODEL 9219

DESCRIPTION

The Model 9219 Card Punch is designed for heavy duty operation with the SEL 32 Series Computers. The input hopper and output stacker (1000 cards each) permit easy on-the-fly loading and unloading of cards. Picking is achieved by side friction, which permits picking one card at a time.

The punch mechanism features a cam drive system that directs punching and the return of punch knives and interposers.

Columns are punched at the rate of 160 per second. The Model 9219 punches 100 cards per minute when 80 columns are punched, and 300 cards per minute when only the first ten columns are punched.

From the input hopper to output stacker, the cards are transported with positive roller control and along a straight-line route.

HIGHLIGHTS

- 100 CPM Rate
- Heavy Duty
- Large Capacity Hopper/Stacker

SPECIFICATIONS

Prerequisites

Model 9107 Card Punch Controller

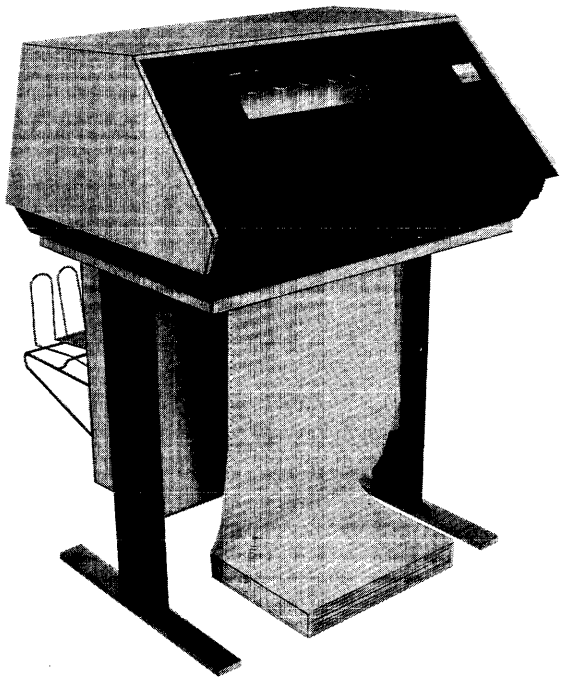
References

Technical Manual 325-329107
Technical Manual 325-329104
Technical Manual Documation P-100

Physical/ Environmental

Height	49.5 in.
Width	38.75 in.
Depth	18.6 in.
Weight	350 lb
Power Requirements	
Voltage	115/230 Vac ±10%
Frequency	60/50 Hz ±1 Hz
Power	900W ±1.1%
Heat Dissipation	3069 Btu/hr
Operating Temp	10°C - 37.7°C
Relative Humidity	30% - 70% (non-condensing)
Thermal Shock	-9.4° C/hr
Altitude	1,000 ft below sea level - 6,000 ft above sea level
Maximum Cable Length to Card Punch Controller	30 ft

Performance	Format	80 Columns, standard rectangular holes
	Hopper/Stacker	1,000-Card capactiy
	Reject Stacker	100-Card capacity
	Pick/Transport Mechanism	Side friction pick, positive roller controlled transport
	Error Detection	Automatic verification utilizing echo check
	Orientation	Column by column with 1-column buffer storage
	Speed	160 columns/sec, 100 cards/min (80 columns), 300 cards/min (10 columns)
	Cable, AC Power	
	Model 9219 (115V, 60 Hz)	
	Plug	Hubble 5921, NEMA configuration 5-15P
	Receptical	Hubble 5262, NEMA configuration 5-15R
	Length	9 ft
	Model 9219-1 (115V, 50 Hz)	
	Cable and connector same as Model 9219.	
	Model 9219-2 (230V, 50 Hz)	
	Plug	Hubble 5925, NEMA configuration 6-15P
	Receptical	Hubble 5462, NEMA configuration 6-20R.
	Length	9 ft



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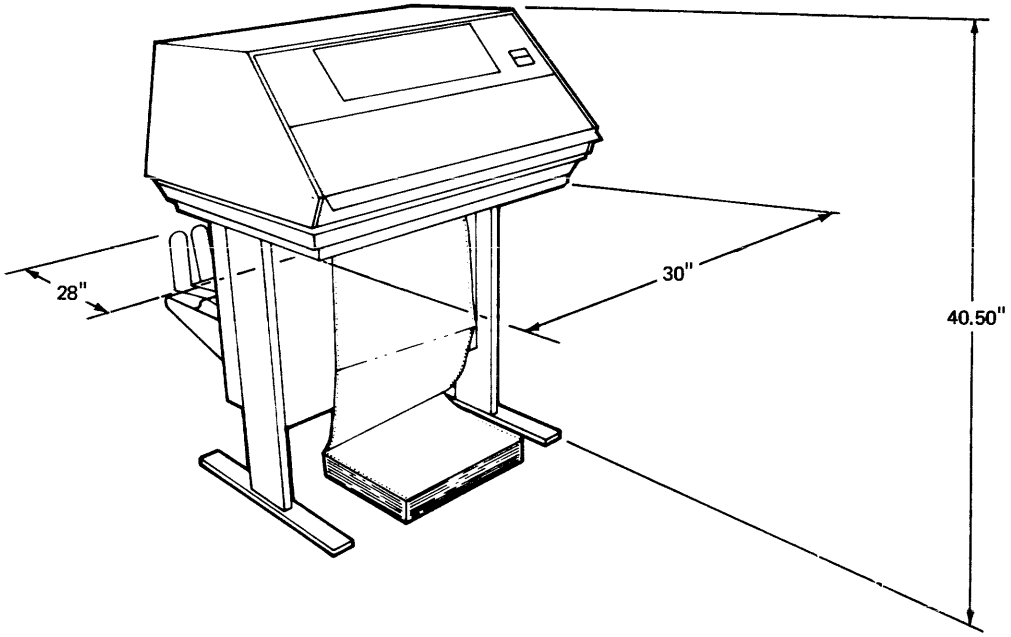


Line Printer Model 9224

LINE PRINTER (125 LPM) MODEL 9224

DESCRIPTION

The Model 9224 Line Printer is a low speed, high performance impact printer. It prints a full 64-character set in a 132-column format at a rate of 125 lines per minute on single and multi-part forms.

The Model 9224 contains a small central processor unit to achieve the complex timing and to regulate the control portions of the printer. Adaptive control logic automatically examines and adjusts each line to maximum possible speed for particular character content.

The printing portion features impact hammers, which print on-the-fly and individually replaceable character slugs on a circulating belt with precision magnetic pickups for timing. Quick paper advance is acheieved by a stepping motor paper drive which is clutchless and brakeless.

Push buttons, on the front panel are Form Feed, Line Feed, Stop, and Print. Indicator lights including Ready, Motor Off, Alarm, and No Paper provide identification of basic printer problems. On the rear panel are the on/off switch, power cable and interface connector. The drum gate swings open to allow ready access for forms loading, ribbon changing, self-test control, and belt motor control. The enclosure has been designed to minimize acoustic noise.

HIGHLIGHTS

- 125 Lines/Min
- 132 Characters/Line
- Full 64-Character Set

Specifications

Prerequisites

Line Printer Channel in Model 9004 TLC Controller

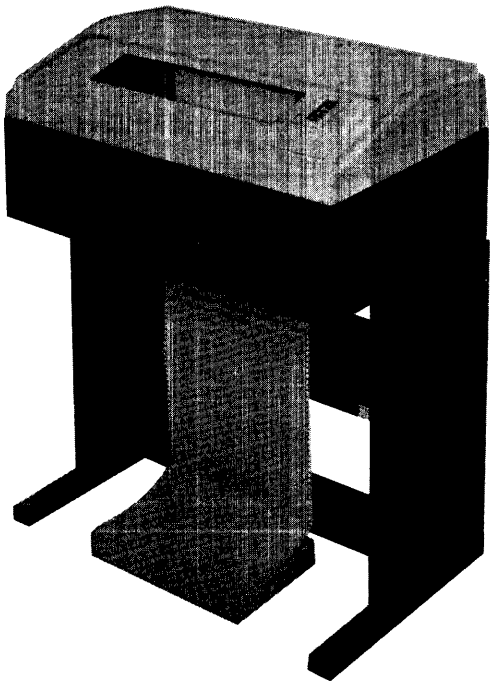
References

Technical Manual 325-32004
Technical Manual Data 100 Model 2422

Physical/ Environmental

Height	40.5 in.
Width	30 in.
Depth	28 in.
Weight	275 lb
Power Requirement	
Voltage	115 Vac ±10% (230 Vac ±10% available as option)
Frequency	60 Hz ±1 Hz (50 Hz ±1 Hz available as option)
Power	400W
Heat Dissipation	1364 Btu/hr
Operating Temp	$10^{o}C$ - $43^{o}C$
Relative Humidity	5% - 95% (non-condensing)
Maximum Cable Length to TLC Controller	30 ft

Performance	Print Rate	125 lpm using 64 characters
	Character Format	132 characters/line
	Character Drum	64-character
	Character Size	Typically 0.096 in. high by 0.059 in. wide
	Data Characters	7-bit ASCII characters and character strobe
	FORMS HANDLING	
	Paper Feed	Pin feed, clutchless and brakless drive system
	Paper Advance Speed	20 ms (single line) 40 ms (double line, selectable)
	Slew Speed	8.33 in./sec
	Forms Adjustments	Horizontal-right or left tractors individually adjustable up to 16 in. range
	Paper Dimensions	Standard fanfold; edge-punched continuous; up to 6-part, 16-in. forms
	Density Control	Left and right vernier controls for accurate control of print quality
	Paper Out Detection	2.25 in. below print line
	Cable, AC Power	
	Model 9224 (115V, 60 Hz)	
	Plug	Hubble 5921, NEMA configuration 5-15P
	Receptical	Hubble 5262, NEMA configuration 5-15R
	Length	15 ft
	Model 9224-1 (115V, 50 Hz)	
	Cable and connectors same as Model 9224.	



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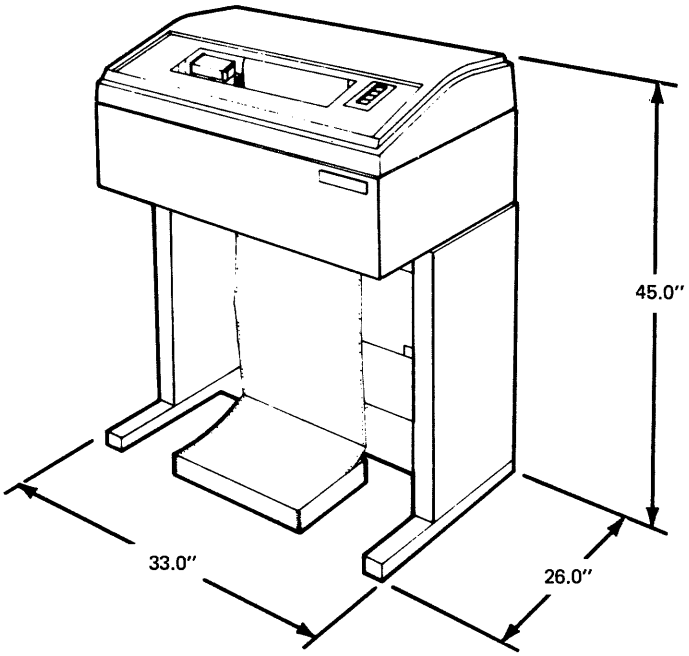


Line Printer Model 9225

LINE PRINTER (300 LPM) MODEL 9225

DESCRIPTION

The Model 9225 Line Printer provides high-quality, medium-speed impact printing.

A print rate of 300 lines per minute is attained when printing a full 64-character set in a 136-column format. The Model 9225 produces printout on a single copy to six-part forms.

A fault indicator panel provides identification of operator correctable problems. The drum gate swings open to allow ready access for forms loading and ribbon changing. The enclosure has been designed to minimize acoustic noise.

A print hammer combines with a clutchless paper feed and voice coil hammer bank positioner to provide highly reliable elements in the printer system.

The electronics and major subassemblies are of modular construction to aid in rapid fault isolation and repair. Preventive maintenance requirements are minimal due to the inherent stability of the printer subsystems.

HIGHLIGHTS

- 300 Lines/Min
- 136 Characters/Line
- Full 64-Character Set

SPECIFICATIONS

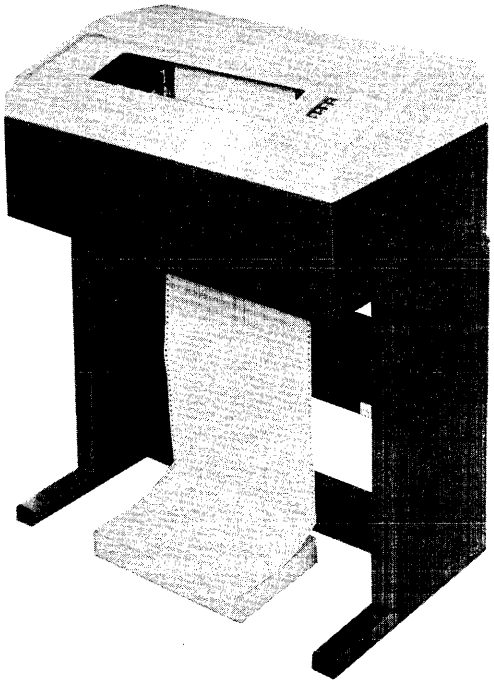
Prerequisites: Line Printer Channel in Model 9004 TLC Controller

References: Technical Manual Data Products DCP234875F/Vol. 1 & 2
Technical Manual 325-329004

Physical/ Environmental

Height	45 in.
Width	33 in.
Depth	26 in.
Weight	340 lb
Power Requirements	
Voltage	115 Vac ±10%
Frequency	60 Hz ±2 Hz
Current	4.5A
Power	525W
Heat Dissipation	1800 Btu/hr
Operating Temp	10°C - 37°C
Relative Humidity	30% - 90% (non-condensing)
Standard Cable Length to TLC Controller	30 ft

PERFORMANCE	Print Rate	300 lpm using 64 characters
	Character Format	136 characters/line (10 characters/in.)
	Character Drum	64-character
	Character Set and Font	Modified ASCII, open gothic DPC-A font with symbols typically 0.095 in. high by 0.065 in. wide
	Paper Dimensions	Standard fanfold, edge-punched continuous forms, 4 in. to 16.75 in. wide
	Paper Type	Single copy, 15-lb bond minimum multi-copy, to 6 parts with 12-lb bond and 7-lb carton
	Format	Top of form control, single line advance and perforation step over
	OPERATOR CONTROLS	
	Push buttons	On/Off-Line, Paper Step, Top of Form, Alarm/Clear
	Lamps	Ready, Power On
	Fault Indicators	Gate, Paper, Ribbon, Hammer, Format, Tape
	Other	Phasing, 6/8 lpi, Forms Reset
	PAPER FEED	
	Mechanism	Single set of pin feed tractors, clutchless drive system
	Single Line Advance	50 ms
	Slew Speed	20 in./sec
	Line Spacing	6 or 8 lines/in. (switch selectable)
	Cable, AC Power	
	Model 9225 (115V, 60 Hz)	
	Plug	Hubble 5921, NEMA configuration 5-15P
	Receptical	Hubble 5262, NEMA configuration 5-15R
	Length	10 ft
	Model 9225-1 (115V, 50 Hz)	
	Cable and connectors same as Model 9225.	
	Model 9225-2 (230V, 50 Hz)	
	Plug	Hubble 5925, NEMA configuration 6-15P
	Receptical	Hubble 5462, NEMA configuration 6-20R
	Length	10 ft



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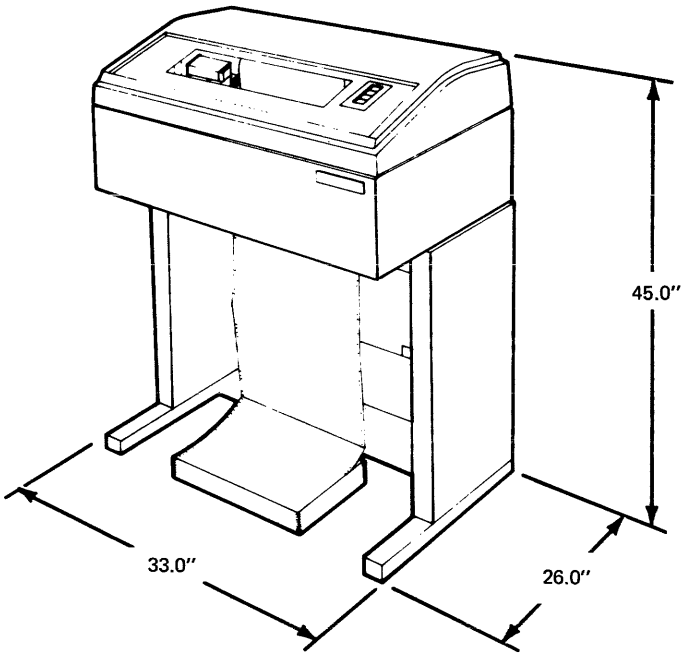


Line Printer Model 9226

LINE PRINTER (600 LPM) MODEL 9226

DESCRIPTION

The Model 9226 Line Printer provides high-quality, medium-speed impact printing.

A print rate of 600 lines per minute is attained when printing a full 64-character set in a 136-column format. The Model 9226 produces printout on a single copy to six-part forms.

The drum gate swings open to allow ready access for forms loading and ribbon changing. The enclosure has been designed to minimize acoustic noise.

A print hammer combines with a clutchless paper feed and voice coil hammer bank positioner to provide highly reliable elements in the printer system.

The electronics and major subassemblies are of modular construction to aid in rapid fault isolation and repair. Preventive maintenance requirements are minimal due to the inherent stability of the printer subsystems.

HIGHLIGHTS

- 600 Lines/Min
- 136 Characters/Line
- Full 64-Character Set

SPECIFICATIONS

Prerequisites

Line Printer Channel in Model 9004 TLC Controller

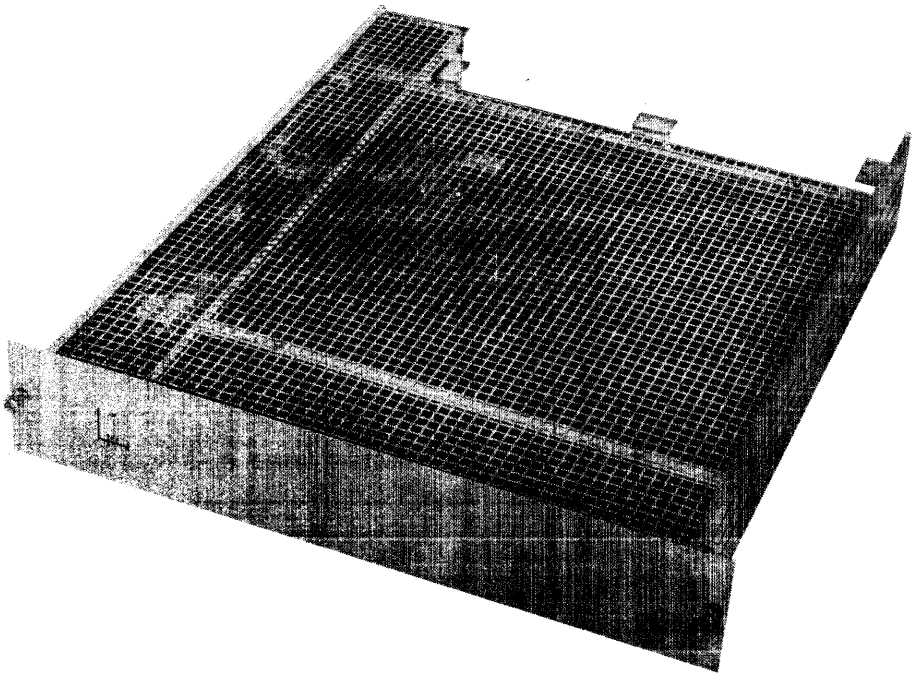
References

Technical Manual Data Products DCP239541/Vol. 1 & 2
Technical Manual 325-329004

Physical/ Environmental

Height	45 in.
Width	33 in.
Depth	26 in.
Weight	370 lb
Power Requirements	
Voltage	115 Vac ±10%
Frequency	60 Hz ±2 Hz
Current	5.9A
Power	680W
Heat Dissipation	2335 Btu/hr
Operating Temp	10°C - 37°C
Relative Humidity	30% - 90% (non-condensing)
Standard Cable Length to TLC Controller	30 ft

Performance	Print Rate	600 lpm using 64 characters
	Character Format	136 characters/line (10 characters/in.)
	Character Drum	64-character
	Character Set and Font	Modified ASCII, open gothic DPC-A font with symbols typically 0.095 in. high by 0.065 in. wide
	Paper Dimensions	Standard fanfold, edge-punched continuous forms, 4 in. to 16.75 in. wide
	Paper Type	Single copy, 15-lb bond minimum multi-copy, to 6-parts with 12-lb bond and 7-lb carbon
	Format	Top of form control, single line advance and perforation step over
	OPERATOR CONTROLS	
	Push buttons	On/Off-Line, Paper Step, Top of Form, Alarm/Clear
	Lamps	Ready, Power On
	Fault Indicators	Gate, Paper, Ribbon, Hammer, Format, Tape
	Other	Phasing, 6/8 lpi, Forms Reset
	PAPER FEED	
	Mechanism	Single set of pin feed tractors, clutchless drive system
	Single Line Advance	25 ms
	Slew Speed	25 in./sec
	Cable, AC Power	
	Model 9226 (115V, 60 Hz)	
	Plug	Hubble 5921, NEMA configuration 5-15P
	Receptical	Hubble 5262, NEMA configuration 5-15R
	Length	10 ft
	Model 9226-1 (115V, 50 Hz)	
	Cable and connectors same as Model 9226.	
	Model 9226-2 (230V, 50 Hz)	
	Plug	Hubble 5925, NEMA configuration 6-15P
	Receptical	Hubble 5462, NEMA configuration 6-20R
	Length	10 ft



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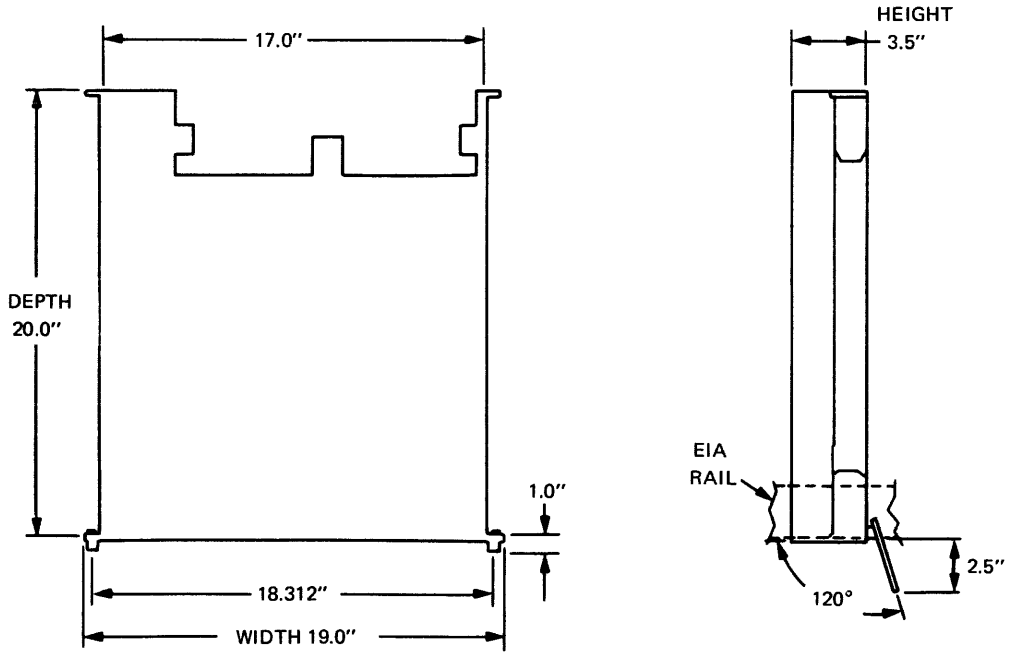


Cartridge Disc Formatter Model 9301

CARTRIDGE DISC FORMATTER MODEL 9301

DESCRIPTION

The Model 9301 Disc Formatter provides all timing and control functions necessary to form a data storage and retrieval system. It will support from one to four cartridge disc drives; these may be either four Model 9306 5M byte drives, four Model 9308 10M byte drives, or a combination of four 5/10M byte drives.

The formatter can execute two disc commands, which are routed directly to the selected disc drive, to cause the positioner to move to the specified cylinder address; and six formatting commands. The formatting commands control transfer of data to or from the disc and can be executed in either a single or multi-sector mode. Formatting commands may be issued after a disc drive seek operation is completed.

The two disc commands are Seek, which causes the positioner to move to the specified address, and Restore, which causes a seek to cylinder 000 for initialization. The six formatter commands include: Read, Write, Verify, Scan High, Scan Low, and Scan Equal.

With the Model 9301, error checking and reporting is comprehensive and includes illegal cylinder error, program error, address error, and data error (SCK check).

HIGHLIGHTS

- Four Discs/Formatter
- Full Error Checking
- Compact
- Completely Digital

Specifications

Prerequisites

Model 9008 Cartridge Disc Controller

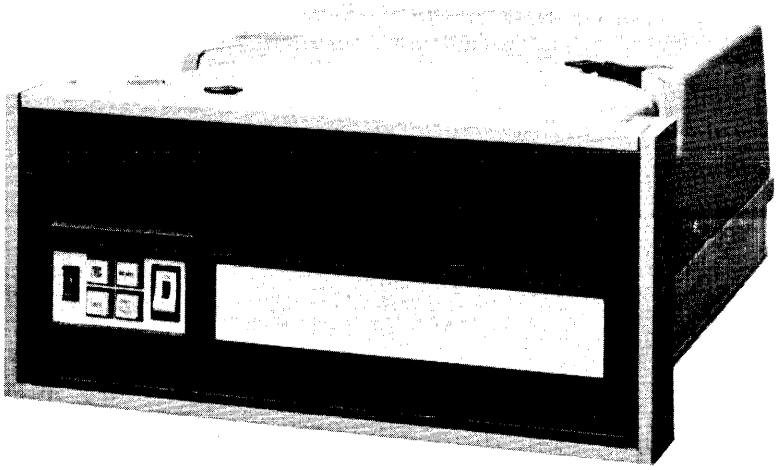
References

Technical Manual Pertec 102537
Technical Manual 325-329008

Physical/ Environmental

Height	3.5 in.
Width	19 in.
Depth	20 in.
Weight	25 lb (approx.)
Power Requirements	
Voltage	100 Vac - 250 Vac ±10% (ten transformer taps)
Frequency	48 Hz - 400 Hz
Power	30W
Heat Dissipation	102 Btu/hr
Operating Temp	2°C - 50°C
Relative Humidity	10% - 95% (non-condensing)
Altitude	0 ft - 20,000 ft
Maximum Cable Length to Cartridge Disc Controller	30 ft
Cartridge Disc Drives	30 ft (total daisy chain)

Performance	Discs/Formatter	4 (max)
	Disc Types	Models 9306 and 9308
	Data Bytes/Sector	384
	Sectors/Track	16
	Spindle Speed	2400 rpm
	Platters/Disc	2 (1 fixed, 1 removable type 2315)
	Data Transfer Rate	312K bytes/sec
	Cable, AC Power	
	Model 9301 (115V, 60 Hz)	
	Plug	Hubble 5921, NEMA configuration 5-15P
	Receptical	Hubble 5262, NEMA configuration 5-15R
	Length	4 ft
	Model 9301-1 (230V, 50 Hz)	
	Plug	Hubble 5925, NEMA configuration 6-15P
	Receptical	Hubble 5462, NEMA configuration 6-20R
	Length	4 ft



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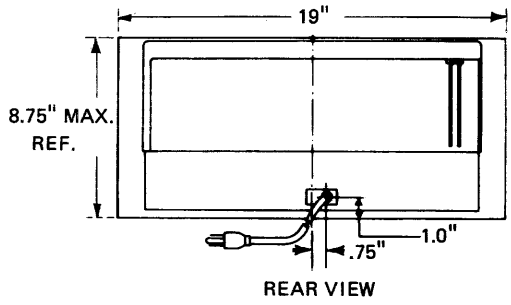
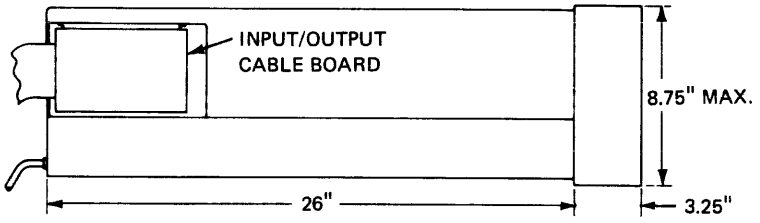
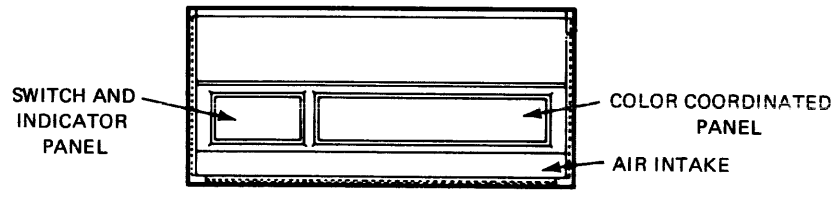


REAR VIEW



LEFT SIDE VIEW



Cartridge Disc Drives Model 930X

CARTRIDGE DISC DRIVES MODELS 9306/9308

DESCRIPTION

The Model 9306 and 9308 Cartridge Disc Drives provide 5-million bytes and 10-million bytes storage capacity, respectively. These disc drives each feature a double disc, which includes a top loading type 5440 cartridge and a fixed disc.

Operating at 2400 revolutions per minute, these cartridge disc drives have an average access time of 35 milliseconds and a data transfer reate of 312K bytes per second.

A high degree of reliability is achieved with these cartridge disc drives because of: an air filtration system that uses a purge cycle on start-up, and a 0.3 micron filter temperature compensation of the mechanics over a wide temperature range, coil positioners and optical detent system to minimize wear, and a track offset feature to aid in recapturing data from a disc recorded from another source.

HIGHLIGHTS

- 5/10M Byte Capacity
- 35 ms Average Access Time
- 312K Bytes/Sec Transfer Rate
- High Reliability

Specifications

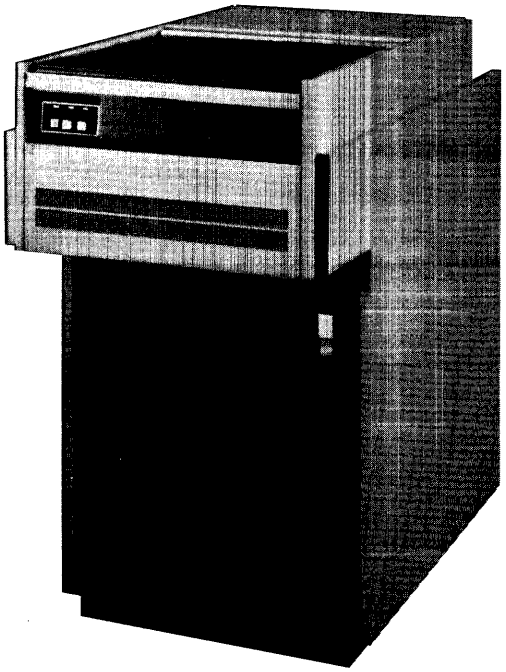
Prerequisites: Model 9301 Disc Formatter (The formatter will support up to four disc drives)

References:
Technical Manual Pertec 102730
Technical Manual 325-329301

Physical/ Environmental

Height	8.75 in.
Width	19 in.
Depth	29.25 in.
Weight	130 lb
Power Requirements	
Voltage	95 Vac - 250 Vac ±10% (ten transformer taps)
Frequency	48 Hz - 52 Hz 58 Hz - 62 Hz
Power	1100W
Operating Temp	10°C - 40°C
Relative Humidity	5% - 85% (non-condensing)
Altitude	0 ft - 7500 ft
Maximum Cable Length to Cartridge Disc Formatter	30 ft (total daisy chain)

Performance	Recording Technique	Frequency doubling	
	Recording Medium	Type 5440 cartridge	
	Bit Density	2200 bpi	
	Bit Rate	2.5 MHz	
	Transfer Rate	312K bytes/sec	
	Disc Drives/Formatter	4	
	CAPACITIES	Model 9306	Model 9308
	Bytes/Drive	4,988,928	9,977,586
	Bytes/Cartridge		
	Fixed	2,494,464	4,988,928
	Removable	2,494,464	4,988,928
	Data Bytes/Sector	384	384
	Sectors/Drive	12,992	25,986
	Sectors/Track	16	16
	Tracks/Drive	812	1,624
	Cylinders/Drive	203	406
	Track Density (tpi)	100	200
	SPEEDS		
	Rotation	2400 rpm ±1%	
	Average Latency	12.5 ms @2400 rpm	
	Positioning (including settle)		
	Track-to-Track	9 ms	
	Average	35 ms	
	Maximum	60 ms	
	Cable, AC Power		
	Model 9306 and 9308 (115V, 60 Hz)		
	Plug	Hubble 5921, NEMA configuration 5-15P	
	Receptical	Hubble 5262, NEMA configuration 5-15R	
	Length	6 ft	
	Model 9306-1 and 9308-1 (115V, 50 Hz)		
	Cable and connectors same as Model 9306		
	Models 9306-2 and 9308-2 (230V, 50 Hz)		
	Plug	Hubble 5925, NEMA configuration 6-15P	
	Receptical	Hubble 5462, NEMA configuration 6-20R	
	Length	6 ft	



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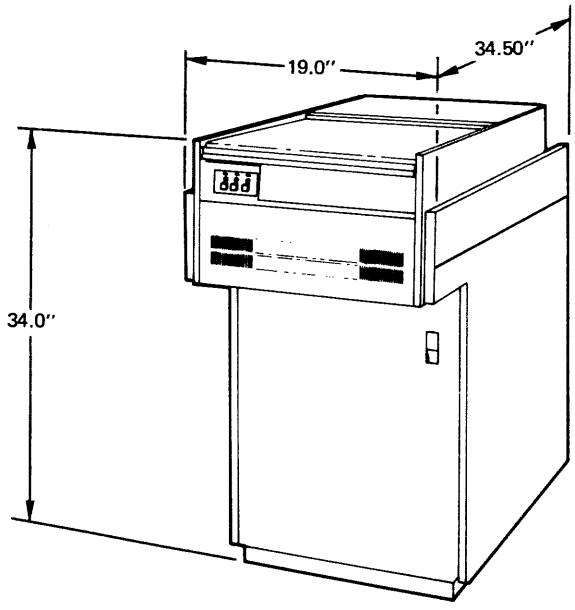


Moving Head Disc Drives Models 932X

MOVING HEAD DISC DRIVES MODELS 9320/9321

DESCRIPTION

The Moving Head Disc Drives provide 80M bytes and 40M bytes of random access storage for the SEL 32 Series Computers. The available models include:

- Model 9320 - 80M Byte Disc Drive
- Model 9321 - 40M Byte Disc Drive

The disc drives use a removable disc pack that contains three oxide redording discs (six surfaces), plus two protective cover discs (total of five). Data can be written on five of the disc surfaces. Positioning information is permanently recorded on the sixth recording surface.

Operating with a spindle speed of 3600 rpm, the Moving Head Disc Drives provide a data transfer rate of 1.2M bytes per second, and have an average random access time of 30 milliseconds. Head positioning is performed by a closed-loop, proportional servo system driving a voice-coil actuator, which provides a track-to-track access time of 7 milliseconds.

A maximum of four Moving Head Disc Drives can be interfaced to the SEL 32 Computer through a single Controller (Model 9010). These four drives must all be the same; i.e., either 40M byte or 80M byte.

Each Moving Head Disc Drive is a self-contained, stand-alone unit. It includes a logic chassis, power supply, forced air cooling system, and the spindle drive assembly.

HIGHLIGHTS

- 40/80M Byte Capacity
- 30 ms Average Access Time
- 1.2M Bytes/Sec Transfer Rate

Specifications

Prerequisites

Model 9010 Moving Head Disc Controller

References

SEL Model 9320
Reference Manual - Control Data Corporation 83308500
Maintenance Manual - Control Data Corporation 83308400
Parts Data Manual - Control Data Corporation 83308600

SEL Model 9321
Reference Manual - Control Data Corporation 70631000
Maintenance Manual - Control Data Corporation 70630900
Parts Data Manual - Control Data Corporation 70631100

Physical/ Environmental

Height	34 in.
Width	19 in.
Depth	34.5 in.
Weight	218 lb
Power Requirements	
Voltage	120 Vac +8 Vac, - 18 Vac
Frequency	60 Hz +0.6 Hz, - 1 Hz
Current	7A (running, PF = .77) 1.5A (standby, PF = .9)
Power	690W (running) 170W (standby)

Physical/ Environmental (Cont'd)	Heat Dissipation	2350 Btu/hr (running) 580 Btu/hr (standby)
	Temperature	15.5°C - 32.2°C (max gradient 6.7 C/hr)
	Relative Humidity	10% - 80% (non-condensing)
	Altitude	1000 ft below sea level - 6000 ft above sea level
	Maximum Shock	2G
	Maximum Cable Length to Model 9010 Controller	50 ft (total daisy chain)

Performance

Characteristic	Model 9320	Model 9321
Actual Storage Capacity	72,687,360	36,299,520
Bytes/Sector	768	768
Sectors/Track	23	23
Tracks/Cylinder	5	5
Cylinder/Drive	823	411
Tracks/Drive	4115	2055
Bits/Inch	6038	6038
Tracks/Inch	384	192
Number of Discs	5	5
Data Surfaces	5	5
Servo Surface	1	1
Media Type	9877	9876
Rotation Speed (rpm)	3600	3600
Data Transfer Rate (M bytes/sec)	1.2	1.2
Access Times (msec)		
Maximum	55	55
Average/Random	30	30
Track-to-Track	7	7

Cable, AC Power

Model 9320 and 9321 (115V, 60 Hz)

Plug	Hubble 5921, NPMA configuration 5-15P
Receptical	Hubble 5262, NEMA configuration 5-15R
Length	6 ft

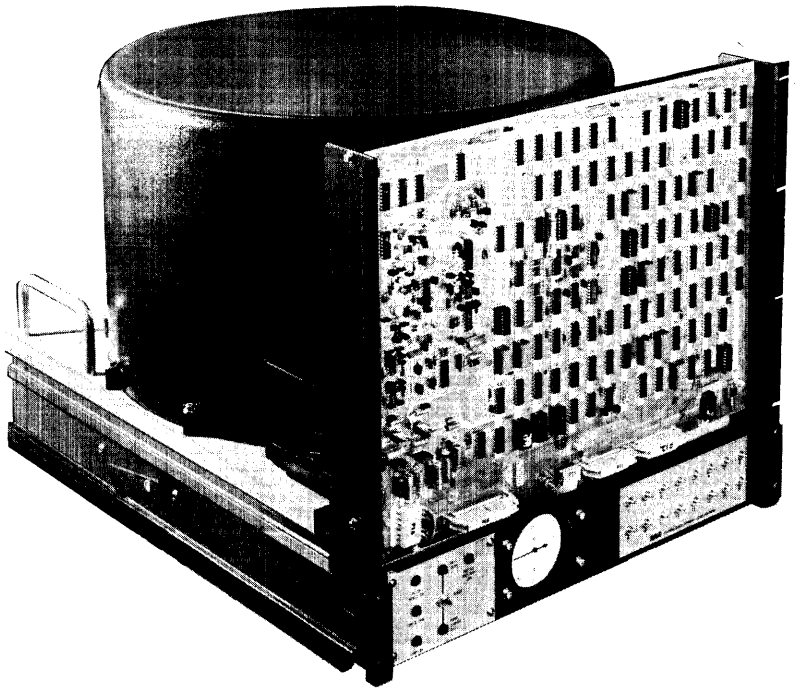
Performance (Cont'd)

Models 9320-1 and 9321-1 (115V, 50 Hz)

Cable and connectors same as Model 9320.

Models 9320-2 and 9321-2 (230V, 50 Hz)

Plug	Hubble 5925, NEMA configuration 6-15P
Receptical	Hubble 5462, NEMA configuration 6-20R
Length	6 ft



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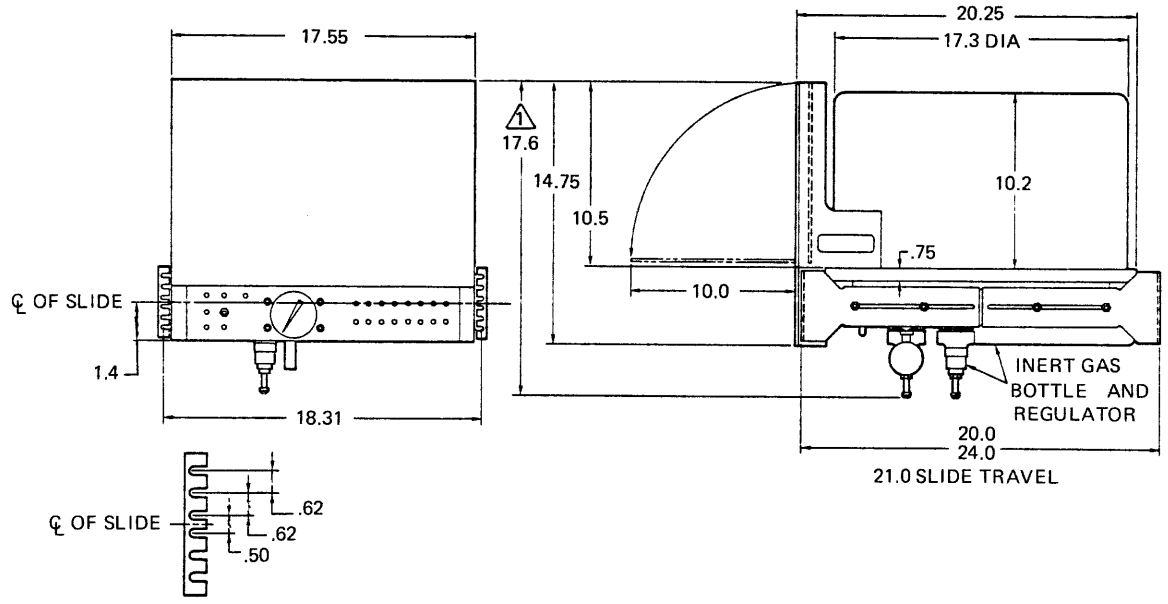

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Fixed Head Discs Models 9337/9338

FIXED HEAD DISC MODELS 9337/9338

DESCRIPTION

The Fixed Head Discs provide SEL 32 users with fast, efficient, mass storage. The system's fast access time and high data transfer rate make it useful for permanent storage of programming systems (monitors, compilers, and assemblers) and temporary storage of program segments to provide very fast overlay necessary for real-time programming.

The Fixed Head Discs are random access, head per tracks disc memory systems, which include electronic circuitry for writing, reading, track selection, and generation of timing signals. Major components of the Disc system consist of a disc storage element, magnetic write/read head assemblies, and write/read/addressing electronics.

A maximum of two Fixed Head Discs can be interfaced to the SEL 32 Computer through a single Controller (Model 9014). Helium Resupply Model 9332 (Helium Bottle and Regulator) and Write Protect Switches are standard for Models 9338 and 9338-1 Discs and optional for Models 9337 and 9337-1 Discs.

HIGHLIGHTS

Models 9337, 9338

- 8.5 MS Access Time
- 8.8M Bits/second Transfer Rate

Models 9337-1, 9338-1

- 10.2 MS Access Time
- 7.33M Bits/second Transfer Rate

SPECIFICATIONS

Prerequisites

Fixed Head Disc Controller Model 9014

References

SEL Fixed Head Disc Models 9337 and 9338
Operation and Maintenance Instructions Digital Data Corporation Manual 1109

Physical/ Environmental

Height	14.75 in.
Width	17.5625 in.
Depth	19.75 in.
Temperature	
Operating	0°C - 40°C 0°C - 50°C**
Non-operating	-40°C - 70°C
Thermal Shock	40°C/hr
Humidity (operating and non-operating without condensation)	5% - 95%
Altitude (without inert gas option)	
Operating	10,000
Non-operating	25,000
Shock (operating and non-operating max. each axis)	5G, 40 ms
Vibration (operating & non-operating)	5G, 5-500 Hz

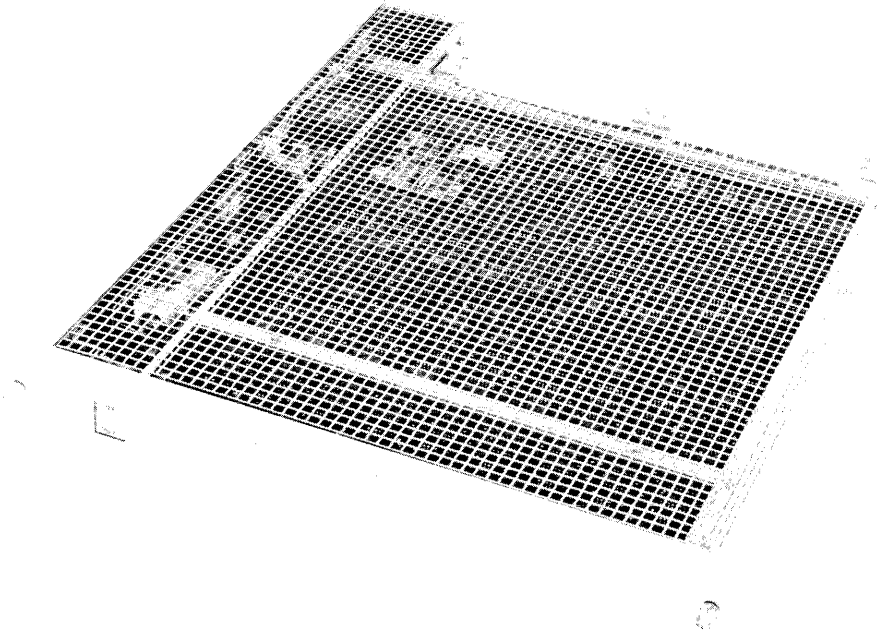
**With inert gas option

Physical/ Environmental (Cont'd)

AC POWER	
Voltage	115V ±10%
Phase	1
Frequency	50 or 60 Hz ±3%
Start Current (maximum)	3.0A
Run Current (nominal)	1.0A
DC POWER	
+25.0 Vdc, 2% regulation	1.5A
+ 5.0 Vdc, 2% regulation	6.5A *9.0A
-12.0 Vdc, 2% regulation	1.0A
MISCELLANEOUS CHARACTERISTICS	
Start Time (nominal)	6 min.
New Weight (nominal)	118 lb
New Weight (with inert gas option)	128 lb
Shipping Weight (nominal)	158 lb

*With sector interlace option.

DATA ORGANIZATION	
Discs (maximum)	2
Tracks per surface	64 + 1 spare
Surfaces per disc	2
Tracks (minimum)	64 + 1 spare
Tracks (maximum)	256 + 4 spares
DATA CAPACITY (maximum unformatted)	
Bits per track	150,000
Bits per surface	9.6×10^6
Bits per system	38.4×10^6
TRANSFER CHARACTERISTICS	
Disc Speed (nominal, rpm)	
60 Hz (Models 9337 and 9338)	3530
50 Hz (Models 9337-1 and 9338-1)	2940
Average Access Time (Nominal, milliseconds)	
60 Hz (Models 9337 and 9338)	8.5
50 Hz (Models 9337-1 and 9338-1)	10.2
Data Rate (nominal Mbits/sec at maximum bits/track)	
60 Hz (Models 9337 and 9338)	8.8
50 Hz (Models 9337-1 and 9338-1)	7.4



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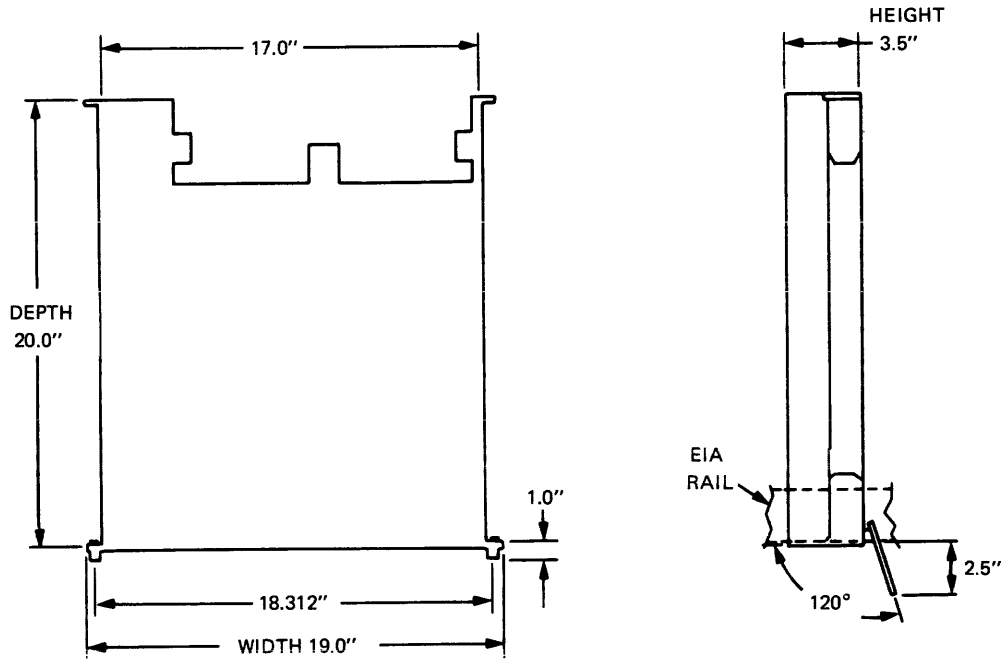


Tape Formatters Models 935X

TAPE FORMATTERS MODELS 9350/9351/9352

DESCRIPTION

A choice of three tape formatters is available for use with the Model 9012 Tape Control Unit and Model 936X and 937X Magnetic Tape Units to form a magnetic tape system for the SEL 32 Series Computers. These systems provide the capability to read and write IBM and ANSI compatible nine-track NRZI and phase-encoded formats. The choice of tape formatters includes: single format NRZI, single format phase-encoded, and dual format for NRZI and phase-encoded.

Single Format NRZI (Model 9350). The Model 9350 Tape Formatter operates and controls a selection of four intermixed 7 or 9-track, 45 ips or 75 ips magnetic tape units. Tape densities may be 556 or 800 bpi for 7-track transports, or 800 bpi for 9-track transports. Formatter functions include tape motion control, parity generation and checking, CRC and LRC character generation and checking, file mark generation and detection, and end-of-record detection.

Single Format Phase-Encoded (Model 9351). The Model 9351 Tape Formatter operates and controls up to four intermixed 45 ips or 75 ips 9-track 1600 bpi phase-encoded magnetic tape units. The PE formatter functions include ID burst generation and detection, data encoding and decoding, data deskewing, single track dropout and error correction, and tape motion control.

Dual Format NRZI/PE (Model 9352). The Model 9352 Tape Formatter can handle 800 bpi 7 or 9-track, or 1600 bpi phase encoded data formats at either 45 ips or 75 ips. The formatter will handle up to four magnetic tape units, either all the same or intermixed.

HIGHLIGHTS

- IBM/ANSI Compatible
- 7/9 - Track
- NRZI/PE
- 45/75 ips

SPECIFICATIONS

Prerequisites

Model 9012 Magnetic Tape Control Unit

References

SEL Tape Formatter Model 9350
Operating and Service Manual Pertec Manual Number 101600

SEL Tape Formatter Model 9351
Operating and Service Manual Pertec Manual Number 101399

SEL Tape Formatter 9352
Operating and Service Manual Pertec Manual Number 101985

Physical/ Environmental

Height	3.5 in.
Width	19 in.
Depth	20 in.
Weight	25 lb
Mounting	Standard EIA Mount (slides provided)
Power Requirements	
Voltage	100 Vac - 250 Vac ±10% (ten transformer taps)
Frequency	48 Hz - 400 Hz

Physical/ Environmental (Cont'd)

Power

	Watts	Heat Dissipation (Btu/hr)
Model 9350	30	102
Model 9351	75	256
Model 9352	100	341

Operating Temp: $2^{o}C$ - $50^{o}C$

Relative Humidity: 10% - 95% (non-condensing)

Altitude: 0 ft - 20,000 ft

Maximum Cable Length to:

Mag Tape Controller: 30 ft

Mag Tape Transports: 30 ft (total daisy chain)

Performance

Characteristic	Model 9350	Model 9351	Model 9352
Format	NRZI	PE	NRZI/PE
Tracks	7/9	9	7/9 - 9
Density (bpi)	556/800	1600	800/1600
Speed (ips)	45/75	45/75	45/75
Compatible Mag Tape Units	9360 9361 9374 9375	9362 9376	9360 9361 9362 9363 9374 9375 9376 9377

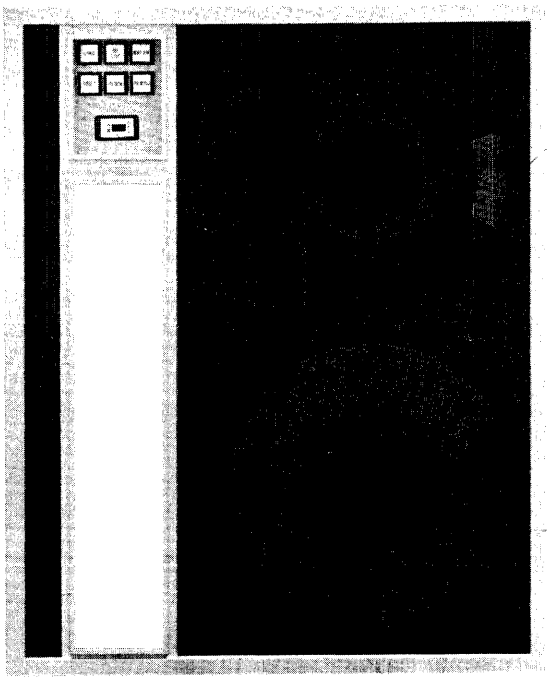
Cable, AC Power

Models 9350, 9351, and 9352 (115V, 60 Hz)

Plug	Hubble 5921, NEMA configuration 5-15P
Receptical	Hubble 5262, NEMA configuration 5-15R
Length	5 ft

Models 9350-1, 9351-1 and 9352-1 (230V, 50 Hz)

Plug	Hubble 5925, NEMA configuration 6-15P
Receptical	Hubble 5462, NEMA configuration 6-20R
Length	5 ft



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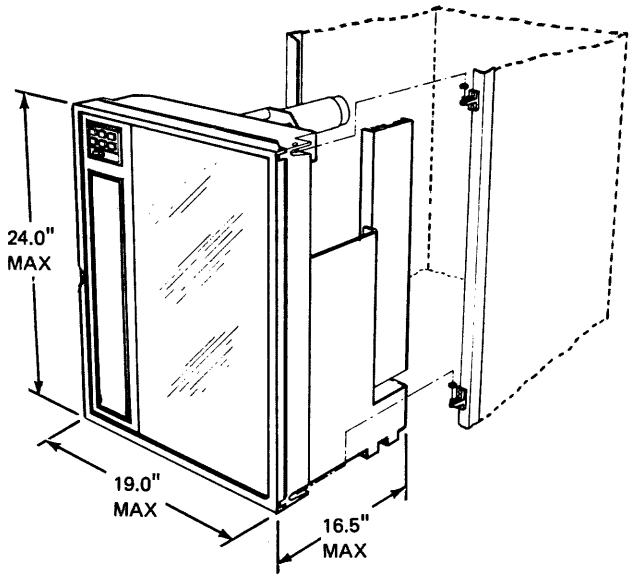


MAGNETIC TAPE TRANSPORTS MODELS 9360/9361/9362/9363

DESCRIPTION

The Model 936X Series Magnetic Tape Transports are high-performance 10.5-inch reel transports. Operating at 45 ips, these transports read and write IBM and ANSI standard 7/9-track NRZI or phase-encoded tape formats for the SEL 32 Series Computers.

The four models available include:

Model 9360	7-track NRZI, 556/800 bpi
Model 9361	9-track NRZI, 800 bpi
Model 9362	9-track PE, 1600 bpi
Model 9363	9-track, electronically selectable 800 bpi NRZI or 1600 bpi PE formats

The Model 936X Series Magnetic Tape Transports have a single capstan, contoured head cover, and automatically retracted buffer arms and require 24 inches of rack height. These transports include data electronics, load point logic and tape motion control electronics. Other features include: single adjustment electronic deskewing, photo-electric buffer arm sensors, automatic reel seating head-down hubs, and 200 ips rewind speed. For convenience during maintenance, front accessible, tilt out electronic boards are featured.

HIGHLIGHTS

- 45 ips
- Tension-Arm Tape Control
- 7/9-Track
- NRZI/PE

SPECIFICATIONS

Prerequisites

Model 9360/9361 requires a Model 9350 Mag Tape Formatter

Model 9362 requires a Model 9351 Mag Tape Formatter

Model 9363 requires a Model 9352 Mag Tape Formatter

References

SEL Magnetic Tape Transport Model 9360 Operators and Service Manual Pertec Manual Number 103380

SEL Magnetic Tape Transport Model 9361 Operators and Service Manual Pertec Manual Number 103380

SEL Magnetic Tape Transport Model 9362 Operators and Service Manual Pertec Manual Number 103381

SEL Magnetic Tape Transport Model 9363 Operators and Service Manual Pertec Manual Number 103382

Physical/ Environmental

Height	24 in.
Width	19 in.
Depth	16.5 in.
Weight	85 lb
Mounting	Standard EIA Rack Mount

Physical/ Environmental (Cont'd)	Power Requirements	
	Voltage	95 Vac - 250 Vac ±10% (ten transformer taps)
	Frequency	47 Hz - 400 Hz
	Power	300 W
	Heat Dissipation	1023 Btu/hr
	Operating Temperature	2°C - 50°C
	Relative Humidity	15% - 95% (non-condensing)
	Altitude	0 ft - 20,000 ft
	Maximum Cable Length to Mag Tape Formatter	30 ft (total daisy chain)
Performance	Tape Speed	45 ips
	Speed Variations	
	Instataneous Long Term	3% (max) 1% forward 3% reverse
	Start/Stop Displacement	0.19 in ±0.02 in. (4.83 mm ±0.51 mm)
	Start/Stop Time	8 ms ±0.55 ms
	Number of Tracks	7/9-track IBM compatible
	Recording Mode	
	NRZI	IBM compatible
	PE	IBM/ANSI compatible
	Tape Format	IBM compatible
	Tape Specifications	0.5 in (12.7 mm) wide, 1.5 mil (38.1μ) thick, computer grade
	Rewind Speed	200 ips (nominal)
	Reel Size	10.5 in (2400 ft, 1.5 mil tape)
	Tape Tension	8 oz (226.7g)
	Density/Transfer Rates	
	Model 9360	25.02 KHz, 556 bpi 36 KHz, 800 bpi
	Model 9361	36 KHz, 800 bpi
	Model 9362	72 KHz, 1600 bpi
	Model 9363	36 KHz, 800 bpi 72 KHz, 1600 bpi
	Tape Transports/ Controller	4

Performance (Cont'd)

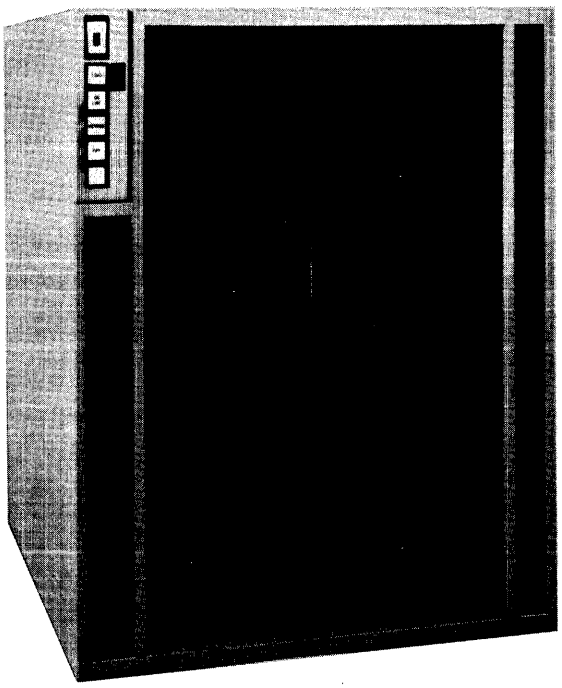
Cable, AC Power

Models 9360, 9361, 9362, and 9363 (115V, 60 Hz)

Plug	Hubble 5921, NEMA configuration 5-15P
Receptical	Hubble 5262, NEMA configuration 5-15R
Length	7 ft

Models 9360-1, 9361-1, 9362-1 and 9363-1 (230V, 50 Hz)

Plug	Hubble 5925, NEMA configuration 6-15P
Receptical	Hubble 5462, NEMA configuration 6-20R
Length	7 ft



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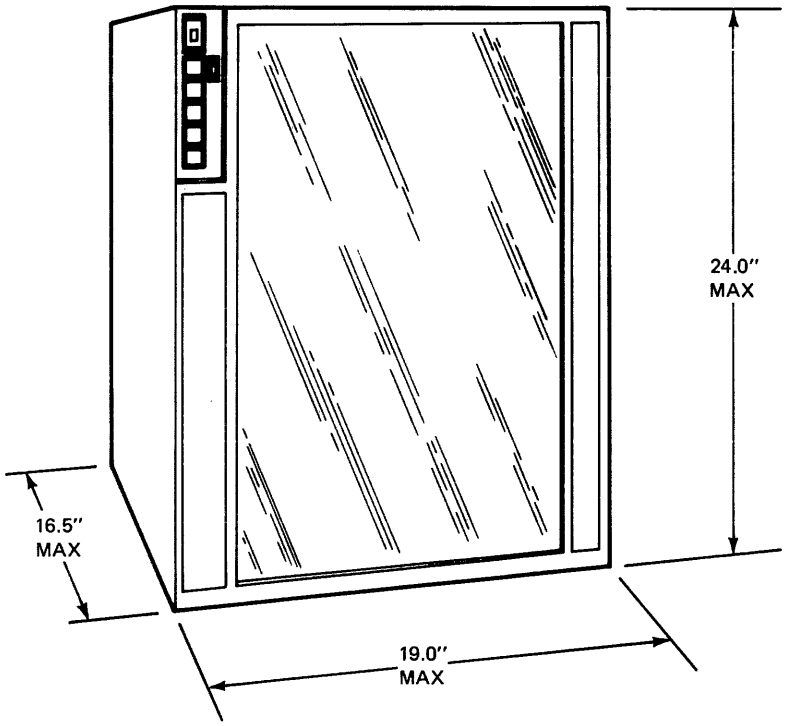


Magnetic Tape Transports Models 937X

MAGNETIC TAPE TRANSPORTS MODELS 9374/9375/9376/9377

DESCRIPTION

The Model 937X Series Magnetic Tape Transports are high-performance vacuum column transports. Operating at 75 ips, these magnetic tape units read and write IBM and ANSI standard 7/9-track NRZI or phase-encoded tape formats for the SEL 32 Series Computers.

The Model 937X series transports have a reel anti-twitch feature and a positive pressure in the tape compartment area to minimize tape contamination.

The four modules available include:

Model 9374	7-track NRZI, 556/800 bpi
Model 9375	9-track NRZI, 800 bpi
Model 9376	9-track PE, 1600 bpi
Model 9377	9-track, electronically selectable 800 bpi NRZI, or 1600 bpi PE formats

HIGHLIGHTS

- 75 ips
- Vacuum Column
- 7/9-Track
- NRZI/PE

SPECIFICATIONS

Prerequisites

Models 9374/9375 require a Model 9350 Formatter

Model 9376 requires a Model 9351 Formatter

Model 9377 requires a Model 9352 Formatter

References

SEL Magnetic Tape Transport Model 9374 Operators and Service Manual Pertec 103905

SEL Magnetic Tape Transport Model 9375 Operators and Service Manual Pertec 103905

SEL Magnetic Tape Transport Model 9376 Operators and Service Manual Pertec 103906

SEL Magnetic Tape Transport Model 9377 Operators and Service Manual Pertec 103926

Physical/ Environmental

Height	24 in.
Width	19 in.
Depth	16.5 in.
Weight	115 lb
Mounting	Standard EIA Rack-Mount
Power Requirements	
Voltage	95 Vac - 250 Vac ±10% (ten transformer taps)
Frequency	47 Hz - 62 Hz
Power	850W

Physical/ Environmental (Cont'd)	Heat Dissipation	2900 Btu/hr
	Operating Temp	5°C - 43°C
	Relative Humidity	30% - 80% (non-condensing)
	Altitude	500 ft below sea level - 4000 ft above sea level
	Maximum Cable Length to Mag Tape Formatter	30 ft (total daisy chain)
Performance	Tape Speed	75 ips
	Speed Variations	
	Instantaneous	3% forward and reverse
	Long-Term	1% forward and reverse
	Start/Stop Displacement	0.19 in. ±0.02 in. (48.3 mm ±0.51 mm)
	Start/Stop Time	5.0 ms ±0.35 ms
	Number of Tracks	7/9-track IBM compatible
	Recording Mode	
	NRZI	IBM compatible
	PE	IBM/ANSI compatible
	Tape Format	IBM compatible
	Tape Specifications	0.5 in. (12.7 mm) wide, 1.5 mil (38.1μ) thick, computer grade
	Rewind Speed	250 ips (nominal)
	Reel Size	10.5 in. (2400 ft, 1.5 mil tape)
	Density/Transfer Rates	
	Model 9374	41.7 KHz, 556 bpi 60 KHz, 800 bpi
	Model 9375	60 KHz, 800 bpi
	Model 9376	120 KHz, 1600 bpi
	Model 9377	60 KHz, 800 bpi 120 KHz, 1600 bpi
	Tape Transports/ Controller	4

Performance (Cont'd)

Cable, AC Power

Models 9374, 9375, 9376,and 9377 (115V, 60 Hz)

Plug	Hubble 5921, NEMA configuration 5-15P
Receptical	Hubble 5262, NEMA configuration 5-15R
Length	5 ft

Models 9374-1, 9375-1, 9376-1 and 9377-1 (230V, 50 Hz)

Plug	Hubble 5925, NEMA configuration 6-15P
Receptical	Hubble 5462, NEMA configuration 6-10R
Length	5 ft

PERIPHERAL CABINET MODEL 9399

DESCRIPTION

The Model 9399 Peripheral Cabinet provides mounting space for the following types of peripherals:

- Up to four Model 9306 or Model 9308 Cartridge Disc Drives with a Model 9301 Cartridge Disc Formatter.
- Up to two Model 936X or Model 937X Magnetic Tape Transports with a Model 935X Magnetic Tape Formatter.
- Combinations of the above Disc Drives and Magnetic Tape Transports.

HIGHLIGHTS

- Side Vent Cooling

SPECIFICATIONS

Prerequisites

SEL 32 Cartridge Disc Drives and Magnetic Tape Transports

References

Technical Manual 303-322000

Physical/ Environmental

Height	71.15 in.
Width	25.12 in.
Depth	32.50 in.
Weight	250 lb (empty, approx)

SECTION IV

REAL-TIME PERIPHERALS

GENERAL

The SEL 32 Computers and Real-Time Peripherals (RTP) can be combined to form data acquisition and control systems to meet a wide variety of real-time process I/O system requirements. A choice of four RTP/CPU interface methods and five different RTP Subsystem types are available. The four RTP/CPU interface methods are:

- Model 7410 Analog/Digital Interface (ADI) - provides a high-speed interface with moderate remoting capability easy switching in dual processor systems.
- Local Asynchronous - provides an RTP interface when the CPU is already equipped with an Asynchronous interface for other RS232C compatible devices.
- Limited Distance Modem - provides for remoting of RTP Subsystems up to four miles over a private twisted pair communications line.
- Secure Remote Control - provides line security for remoting RTP Subsystems over common carrier dial-up telephone lines or private communication lines.

The five types of RTP Subsystems available are:

- Series 7430 Digital and Universal I/O Subsystems
- Series 7440 Analog Output Subsystem
- Series 7470 Low-Level Analog Input Subsystem
- Series 7460 High-Level Analog Input Subsystem
- Series 7480 Wide Range Analog Input Subsystem

The salient characteristics, features, and limitations of the four RTP/CPU interface methods and five RTP Subsystem types are described in the following paragraphs.

RTP/CPU INTERFACES

Model 7410 Analog/Digital Subsystem Interface (ADI)

The Model 7410 ADI, which is shown in figure 4-1 provides a high-speed interface for connecting from one to eight RTP Subsystems to the SEL 32 Computer. Through the use of the Model 7410-1 option, up to 16 RTP Subsystems can be interfaced through a single ADI.

The ADI is implemented on a standard SEL 32 IOM (Input/Output Micro-programmed Processor) and plugs directly into the SEL Bus. High-speed coaxial links are used to transfer data and commands between the ADI and the RTP Bus(es). A Serial Link Transceiver (SLT), which plugs into a dedicated slot in the first RTP Subsystem, provides the conversion between the serial link and the parallel RTP Bus.

The maximum thruput of the ADI is variable and depends on several factors, including ADI priorities and conflicts with the CPU and other IOM's for memory access. However, if these factors are minimized, the typical aggregate rates (16-bit transfers per second) are 100K with single RTP bus and 90K with dual RTP bus for all modes. The maximum data transfer rates for the Analog Input/Output Subsystems are dependent on the latency times associated with the individual subsystems.

Because coaxial cables are used to connect the ADI to the RTP equipment, remoting and switching of the RTP equipment are greatly simplified.

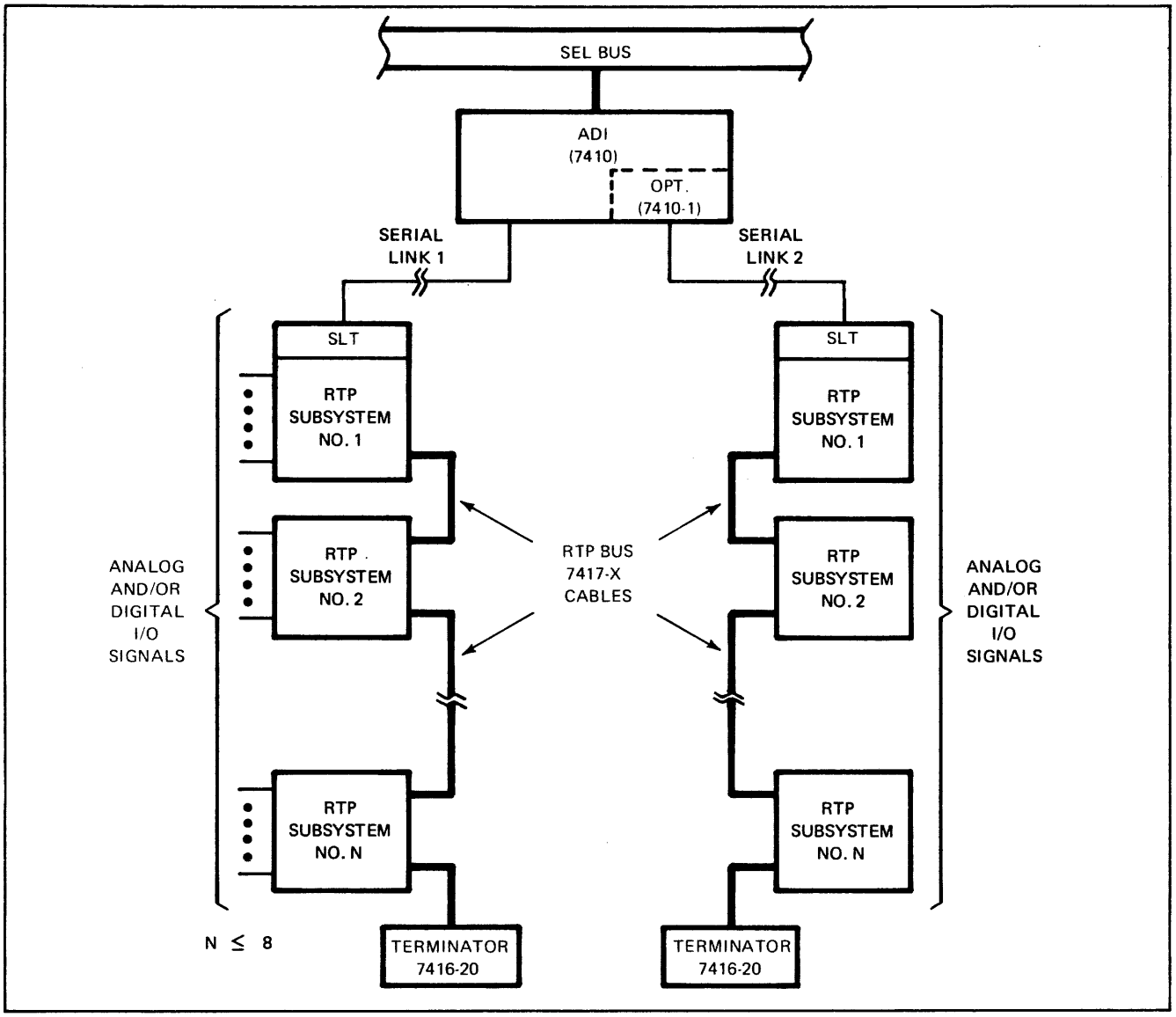


Figure 4-1. System Block Diagram with ADI

RTP/CPU INTERFACES (Cont'd)

Remoting is simplified because maximum cable distances are a function of cable quality rather than drive or noise considerations associated with parallel interfaces. The standard cable length for the ADI serial link is 100 feet; however, longer cable lengths are available on special orders.

In dual processor systems, RTP equipment can be switched between two CPU's.

Local Asynchronous

The Model 9122 Asynchronous Data Set Interface (ADSI) can interface RTP equipment to the SEL 32 Computer if: (1) A spare channel is available on an ADS which is in the system to support other RS232C compatible devices; and (2) the system application is not time critical.

Figure 4-2 shows a block diagram of a system using the Local Asynchronous interface method. Each of the four channels on the ADS can handle up to four RTP Subsystems; however, the full expansion capability would not normally be used since one or more of the ADS channels would be used for other non-RTP devices.

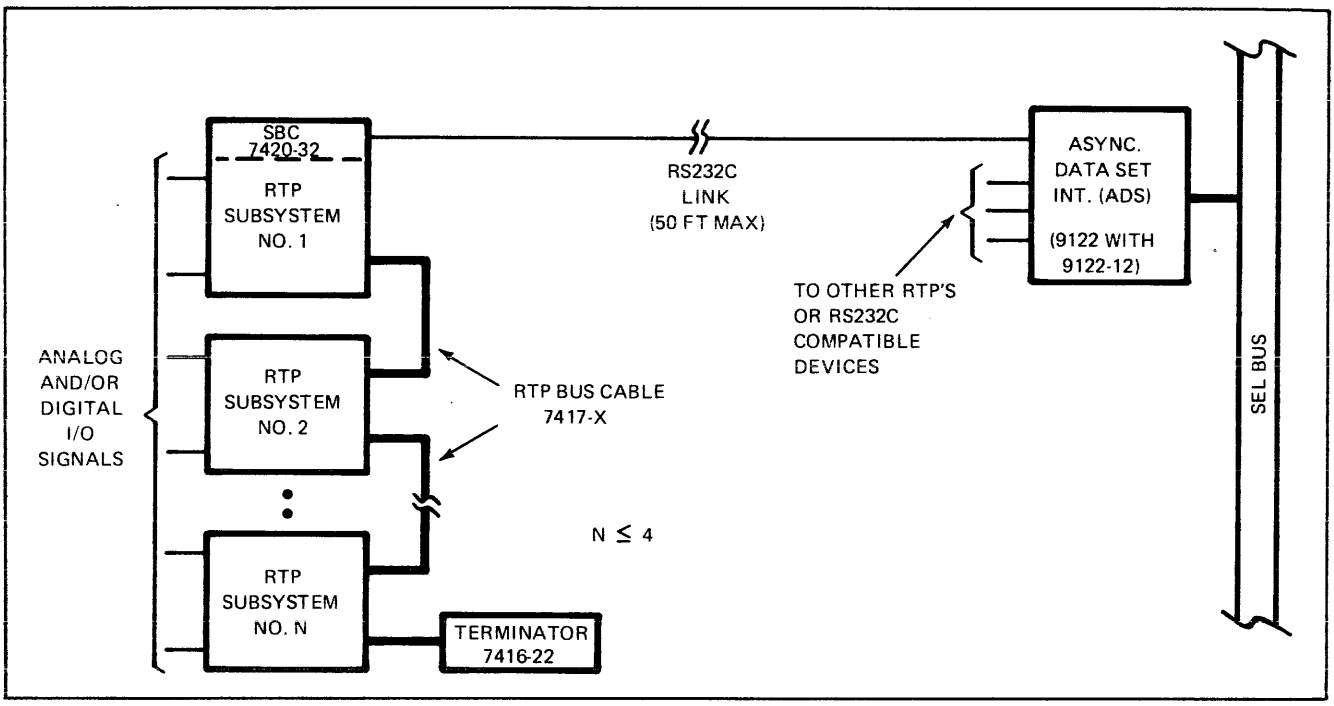


Figure 4-2. System Block Diagram with Local Asynchronous Interface

RTP/CPU INTERFACES (Cont'd)

All data and commands between the ADS and RTP equipment are transmitted over the RS232C Asynchronous line at rates up to 19,200 baud. The actual "data" rates however, are determined by several other factors; these are: (1) the direction of transfer (input or output), (2) the type of RTP Subsystem (analog or digital), (3) the addressing mode (Random, Sequential, or Repeated), and (4) the priorities that are assigned for the Service Interrupts and SEL Bus.

Because of hardware considerations, the ADS/RTP Handler operates in a byte-oriented interrupt-driven mode, resulting in high software overhead to service the interrupts. While that data is being transferred to and from the RTP equipment, other processing in the SEL 32 CPU must be suspended.

The approximate data transfer rates and the number of Service Interrupts that must be processed are shown in Table 4-1 for various subsystem types and addressing modes.

Limited Distance Modem

The Limited Distance Modem interface method is particularly well suited for applications that have slow transfer rate requirements but must have the acquisition equipment remoted up to four miles from the CPU.

From a programming and thruput standpoint, the Remote Private Line is exactly the same as the Local Asynchronous Method. The Limited Distance Modems are transparent to the operation of the system and only serve to extend the RS232C Asynchronous interface.

A system using the Limited Distance Modems is shown in a block diagram in figure 4-3. The Model 7420-30 Remote Serial Link consists of two Limited Distance Modems and a Serial Bus Converter (7420-32). All interconnecting cables, except for the 4-mile twisted pair communication line, are also included.

Table 4-1. ADS/RTP Interface Transfer Rates and Service Interrupts (SI)

Mode / Subsystem	RANDOM		SEQUENTIAL		REPEAT	
	Max Rate	SI's	Max Rate	SI's	Max Rate	SI's
Digital Output	833	4n	833	4n	1.67K	2n + 2
Digital Input	566	6n	566	6n	833	4n + 2
Analog Output	833	4n	833	4n	1.67K	2n + 2
W-R Analog Input	200	6n	200	6n	N/A	N/A
W-R Analog Input/Autorange	200	8n	200	8n	N/A	N/A
H-L Analog Input	566	6n	566	6n	N/A	N/A
L-L Analog Input	566	6n	566	6n	N/A	N/A

NOTES:

1. The Max Rates shown are for 16-bit transfers and assume exclusive use of the ADS. The rates are aggregate rates for the ADS and may be distributed over from one to four asynchronous channels per ADS.

2. Each SI requires approximately 300 microseconds to process. "n" represents the number of "data" transfers to be performed. For example, two random DI transfers require 6X2=12 SI's.

3. The Max rate for the W-R Subsystem is limited by the W-R Gate Cards, not the ADS.

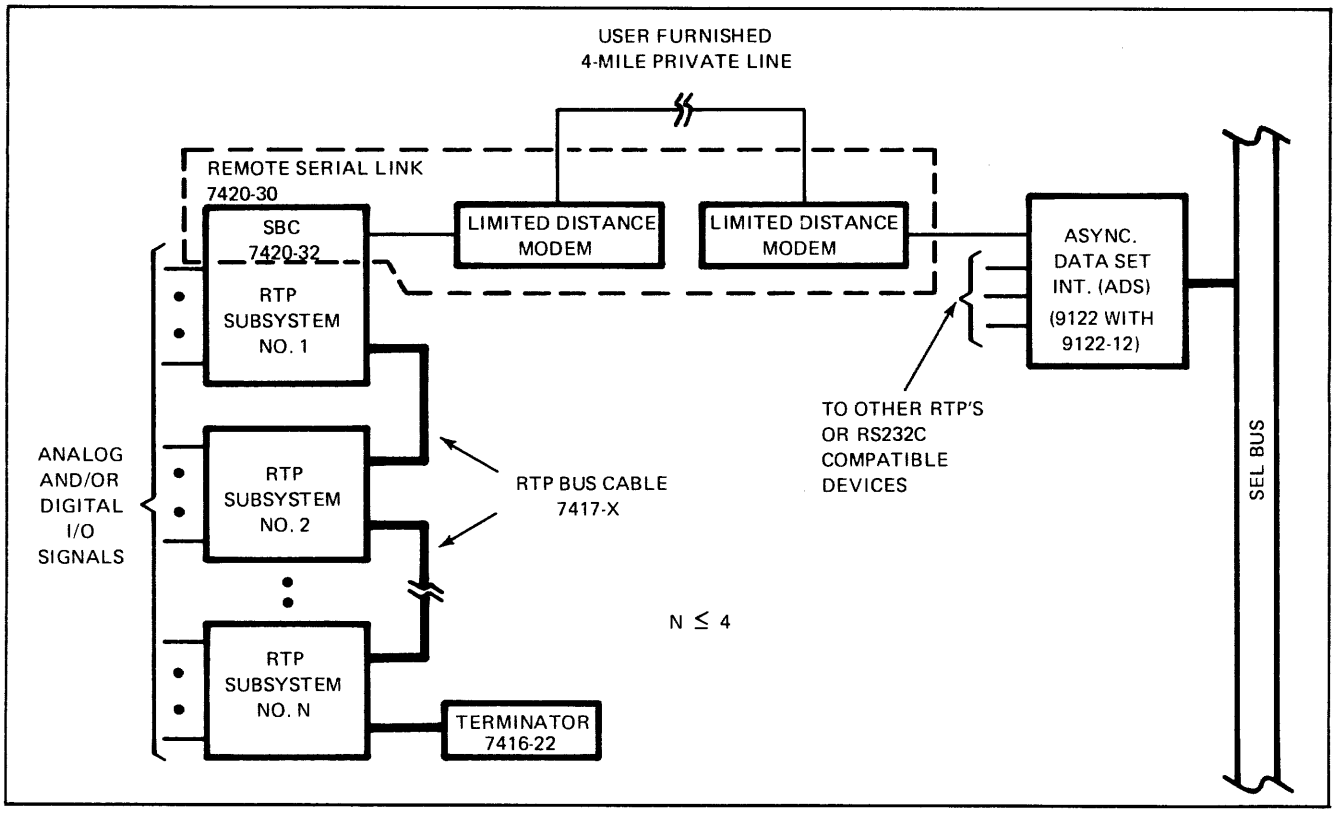


Figure 4-3. System Block Diagram with Remote Private Line

RTP/CPU INTERFACES (Cont'd)

Secure Remote Control

The SEL 32 Computer can be interfaced to remote RTP's over dial-up common carrier or dedicated lines through Procom I, a remote microprocessor-based communication controller. However, no standard software is provided with the SEL 32 Series Computers to support this hardware configuration.

Figure 4-4 shows a block diagram of a system using Procom I. The complete interface network consists of a Model ADS in the SEL 32 Computer, a modem at each end of the communications line, and the Procom I at the remote site.

Communications can be effected over a private line system using Limited Distance Modems at rates up to 19,200 baud, or at slower rates over longer distances using standard asynchronous modems on common carrier dedicated or dial-up lines.

Maximum efficiency and thruput are obtained by storing RTP configuration and control information in Procom I Memory at the remote site. This information (called a Scan Control List), when accessed by the SEL 32 Computer, is used by Procom I to control and format all data transfers over the communications line.

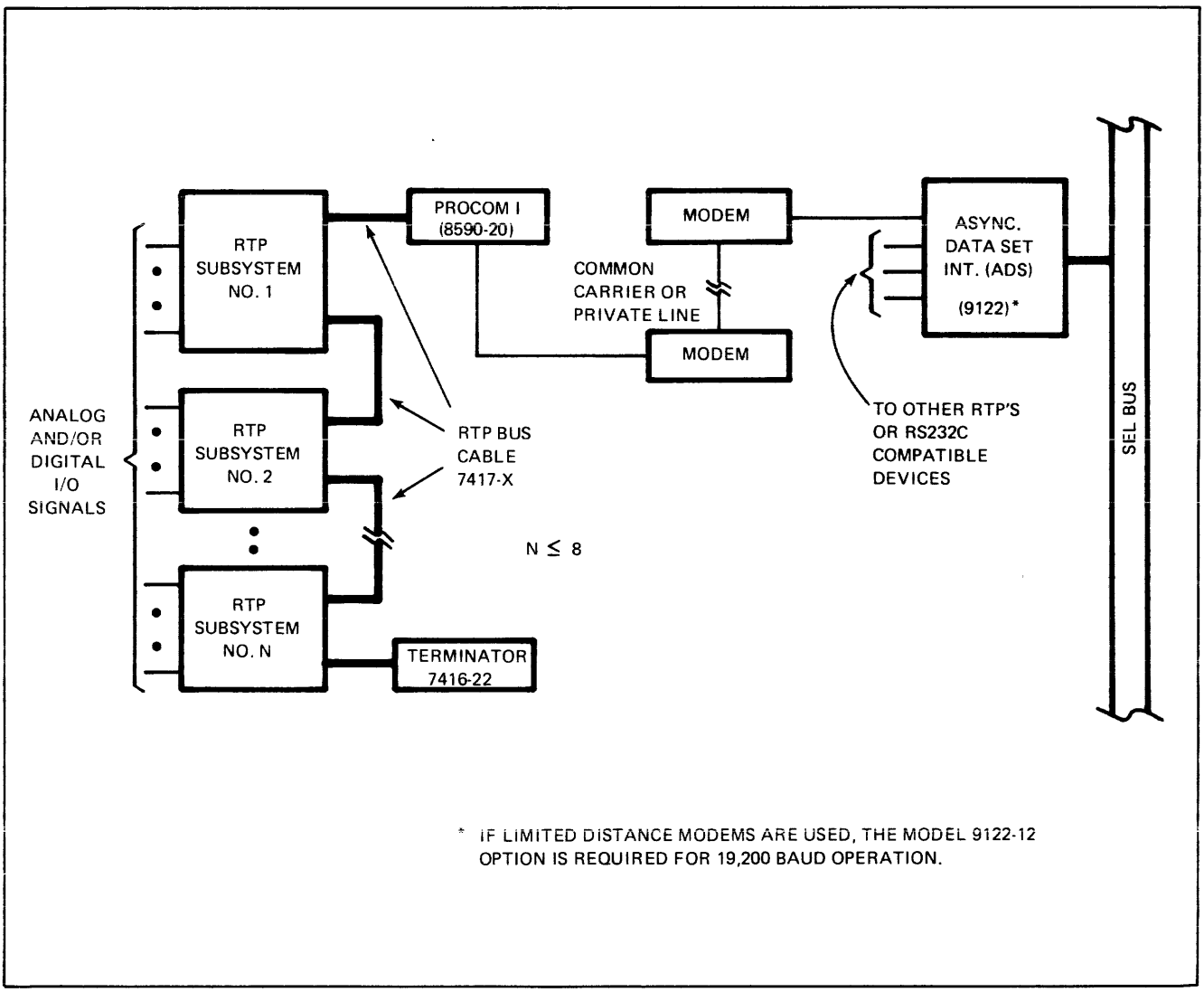


Figure 4-4. System Block Diagram - Secure Remote Control

Series 7430 Digital and Universal I/O Subsystems

The Series 7430 Digital and Universal I/O Subsystems provide a modular approach to the implementation of a wide variety of real-time I/O requirements.

The Model 7430-20 Digital I/O Controller is in a rack mount chassis and includes an integral digital power supply. The chassis provides slots for up 16 Series 7435 Digital I/O Modules in any combination.

The Model 7430-30 Universal I/O Controller is the same as the Digital I/O Controller, except that it also has an analog power supply. This permits the Universal I/O Controller to handle both the Digital I/O Modules and Analog I/O Modules.

The following is a partial list of modules that plug into the Series 7430 Digital and Universal I/O Subsystems:

- 16-Bit Digital Input (with or without filters)
- 8-Bit Optically Isolated AC Input
- 16-Bit Optically Isolated Digital Input
- 16-Bit Change-of-State Interrupt
- 16-Bit Digital Output
- 8-Bit AC Output
- 16-Bit Relay Output
- 16-Channel A/D Output
- 8-Channel A/D
- D/A Converter

Each of the Digital I/O Modules is available with a choice of a single conditioning options to exactly match the module to the external equipment. These options include TTL, positive voltage, negative voltage, electronic switch, contact sense, etc. In addition, the modules can be configured to operate with internal or external synchronization.

Series 7440 Analog Output Subsystem

The Series 7440 Analog Output Subsystems provide a choice of either ±5.12 or ±10.24V outputs. Each Analog Output Controller provides slots for up to 16 four-channel Sample and Hold Analog Output Cards.

The Analog Output Subsystems can be operated in either a random or sequential addressing mode with update rates up to 20,000 channels per second.

The digital data format is 12-bit twos complement binary. This results in resolutions of 2.5 millivolts per bit and 5.0 millivolts per bit for the ±5.25V and 10.25V models, respectively.

Series 7460 High-Level Analog Input Subsystem

The Series 7460 High-Level Analog Input Subsystems are available with either ±4.096, ±5.12, or ±10.24V full scale input ranges. The High-Level Controllers include a 12-bit A/D converter and slots to accomodate 16 eight-channel single-ended or differential gate cards. Up to 128 high-level analog input channels can be sampled at rates up to 20,000 channels per second.

The single-ended gate cards have a gain of unity; however, the differential gate cards can be configured to have a gain of 1, 2, 4, or 8. Therefore, within a single Analog Input Sybsystem, different groups of channels may have different full-scale gain ranges. For example, if the ±10.24V High-Level Controller is used with four differential gate cards (each with a different gain), input gain ranges of ±10.24, ±5.12, ±2.50, and ±1.28V are available.

Options for the High-Level Analog Input Subsystem include 13, 14, and 15-bit A/D converters, and gate cards with filters and overvoltage protection.

Series 7470 Low-Level Analog Input Subsystem

The Low-Level Analog Input Subsystem can operate at 8000 samples per second in a random addressing mode. Eight program-selectable gain ranges from ±5 millivolts to ±1 volt are available. These gain ranges may be individually selected for each channel being sampled. The Low-Level Controller includes a 12-bit A/D converter and slots for up to 16 four-channel gate cards.

Other features include very high isolation between channels, high common mode voltage tolerance, and high common mode rejection.

Series 7480 Wide-Range Analog Input Subsystem

The Series 7480 Wide-Range Analog Input Subsystems feature expansion capability up to 512 channels in 8-channel increments.

Four Wide-Range Controllers are available; these controllers provide 200, 100, 40, and 33.33 samples per second (SPS). The A/D converter resolution is 13-bits binary for the 200 and 100 SPS controllers and 15-bits binary for the 40 and 33.33 SPS controllers.

The basic Wide-Range Controller, which is in a rack mount chassis, provides slots for 16 eight-channel gate cards. Full expansion of the system is achieved through the addition of three Expansion Chassis.

Two types of Wide-Range Gate Cards are available: dry-reed relay gate cards and mercury-wetted relay gate cards. The dry-reed types can sample at 200 samples per second, and the mercury-wetted types at 100 samples per second. Both types are available with no filters, or single-pole filters, or double-pole filters.

The Wide-Range Analog Input Subsystem also features 13 programmable gain ranges from 2.5 millivolts to 10.24 volts full-scale and high common mode rejection.

Options for the Wide-Range Analog Input Subsystem include a Display and Control Panel, Programmable Voltage Calibrator, Open Transducer Detection, and Automatic Gain Ranging.

BARRIER TERMINAL STRIP CABLE ASSEMBLIES

Barrier Terminal Strip Cable Asemblies (BTSCA) are available for connecting the individual RTP I/O Modules to the external cabling. Figure 4-5 shows a typical arrangement.

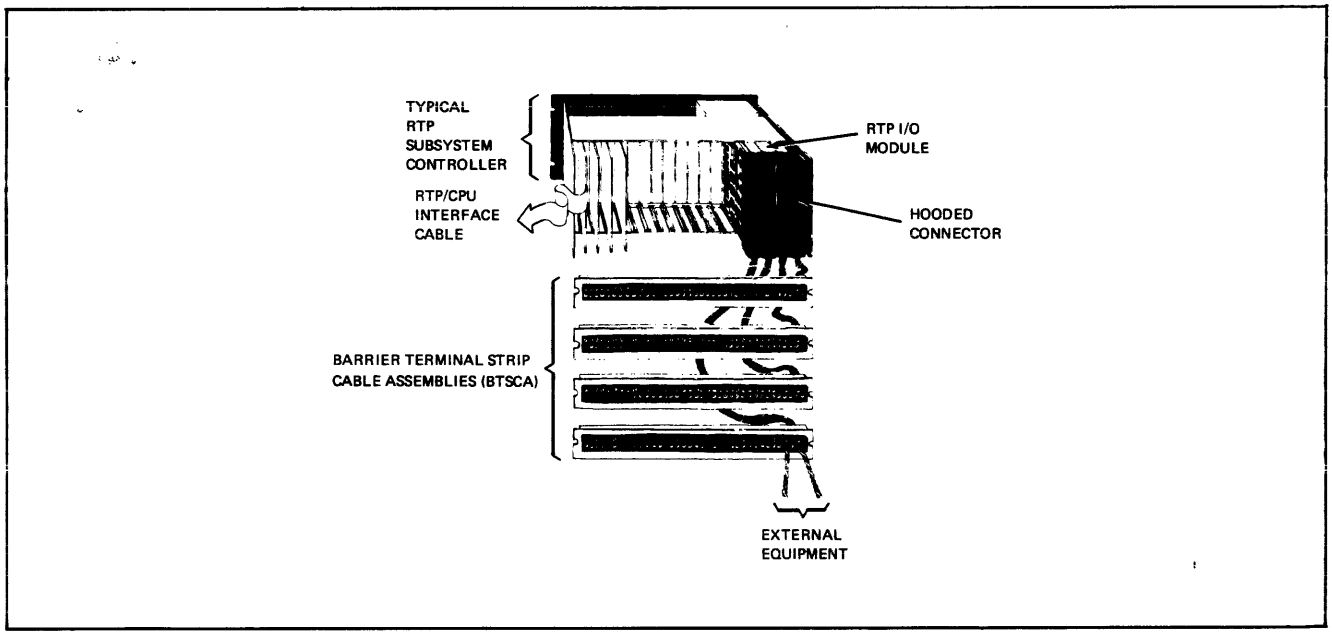
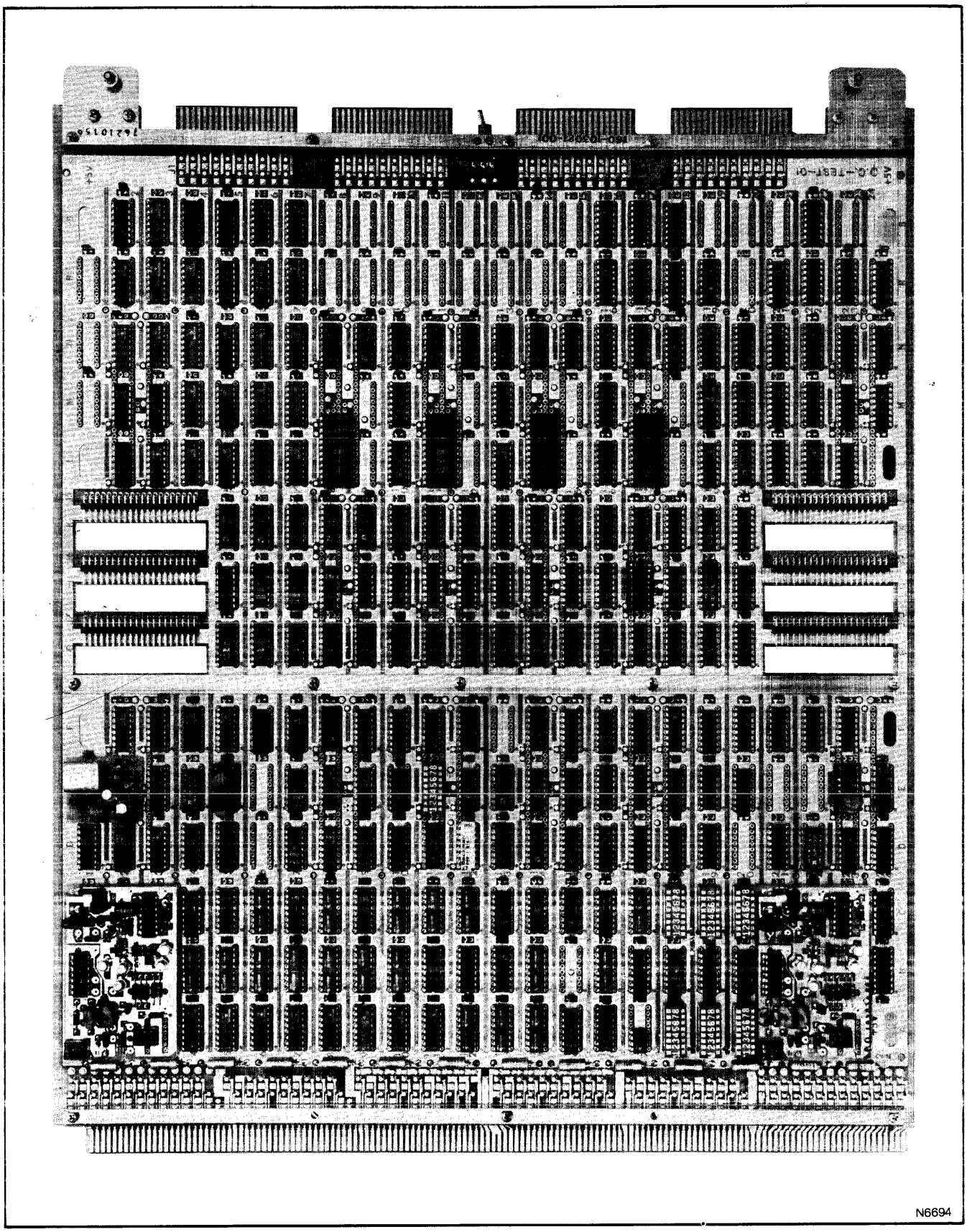


Figure 4-5. RTP Chassis with BTSCA

BARRIER TERMINAL STRIP CABLE ASSEMBLIES (Cont'd)

Usually, each digital I/O Module requires a BTSCA. However, for some analog I/O modules, more than one module can be connected to a BTSCA.

In addition to providing the termination, specialized BTSCA's are available with optical isolation and over-voltage protection.



Model 7410 Analog/Digital Subsystem Interface

ANALOG/DIGITAL SUBSYSTEM INTERFACE MODEL 7410

DESCRIPTION

The Model 7410 ADI and associated Real-Time Peripheral (RTP) Subsystems interface the SEL 32 Computers to External real-time events and processes.

The Model 7410 ADI is implemented on a standard SEL 32 Input/Output Microprogrammable Processor (IOM) and consists of a SEL Bus interface, a microprogrammed processor with a 32-bit wide control memory, and a high-speed serial link interface to the RTP Subsystems. A remote serial link transceiver, which plugs into a dedicated slot in the first RTP Subsystem, provides the interface to the RTP Bus. Up to eight RTP Subsystems can be daisy chained on the RTP Bus.

As an option, the Model 7410-1 provides a second serial link to support a second RTP Bus. Therefore, with the Model 7410-1, a total of 16 RTP Subsystems can be interfaced to the SEL 32 through a single ADI.

The ADI can be used to interface the following types of RTP Subsystems to the SEL 32 Computer:

Model Series	Real-Time Peripheral Subsystems
7430	Digital and Universal I/O Subsystems
7440	Analog Output Subsystem
7460	High-Level Analog Input Subsystem
7471	Low-Level Analog Input Subsystem
7480	Wide-Range Analog Input Subsystem

Any combination of the five types of RTP Subsystems can be connected to either of the two RTP Buses. The ADI can interleave data transfers between the RTP buses allowing both to be active concurrently.

HIGHLIGHTS

- Support for Intermixed Analog Input, Analog Output, Digital Input, and Digital Output Subsystems.
- Transfer Rates up to 100,000 16-bit Transfers per Second in a Random Mode
- Up to 8 or, Optionally, 16 RTP Subsystems per ADI
- High-Speed Serial Link for Easy Remoting of RTP Subsystems
- Simplified Programming Using ISA Standard FORTRAN Callable Subroutines
- Block Transfers Directly To/From Memory
- Automatic Status Posting
- Efficient System Operation Through Command Chaining and Transfer In Channel Capability
- Random, Sequential, and Repeated Channel Addressing Modes

SPECIFICATIONS

Prerequisites	SEL 32/5X	
References	Technical Manual 325-327410	
Physical/ Environmental	Dimensions	15 in. x 18 in. (plug-in board)
	Weight	3 lb
	SEL Bus Requirement	2 slots

Physical/ Environmental (Cont'd)	Power Requirements	Provided by CPU
	Environmental	Same as CPU
	Maximum Cable Lengths	
	ADI to First RTP	100 ft (standard) 250 ft (optional) >250 ft (special quote)
	ADI to Last RTP on RTP Bus (First RTP to Last RTP on Daisy Chain)	50 ft

Note

Installation requirements for the remaining equipment that comprises the RTP Subsystems will be added to the manual at a later date.

SECTION V

SUPPORT FUNCTIONS

MAINTENANCE

INTRODUCTION

To receive the fullest potential of a process computer system, a thorough maintenance plan must be initiated.

Well-trained personnel, supplied with the proper test equipment and a selected set of spare replacement Printed-Wiring-Boards and components, comprise the essential parts of such a plan. SEL has several standard maintenance and training schedules for the customer; some are presented in this section, though pricing must be considered as ficticious, as it is not the purpose of this manual. We fully appreciate that each customer has special problems and we are always ready to negotiate and help devise a suitable plan.

Typical spare parts kits are listed as a guideline to what is available as standard. Special and large systems have different requirements, and SEL will generate appropriate listings in these cases. We recommend the customer add these spares to his original purchase order so they may be delivered at the same time as the system. Additionally, this will aid the Project Engineer assigned in recommending an appropriate storage cabinet for the customer. The recommended test equipment is best selected on the basis of the system configuration and the extent of maintenance the customer will perform himself should be discussed with a SEL representative as soon as possible after purchase.

CONTRACT MAINTENANCE

Comprehensive Maintenance

SEL shall provide on-call maintenance (labor and parts) necessary to keep the equipment in good operating condition at the prices shown in the price list. Maintenance service shall not include electrical work external to the equipment, the furnishing of supplies, or adding or removing accessories, attachments or other devices. Service on custom hardware will be quoted from the Home Office.

Remedial maintenance shall be performed after notification that the equipment is inoperative. SEL shall provide the customer with a designated point(s) of contact and make arrangements to enable its maintenance representative to receive such notification. Preventive maintenance will be performed during the customer's normal working hours.

Within a 25 mile radius of a service area, the basic monthly charges shall entitle the customer to "on call" service during any eight (8) hours between 7:00 A.M. and 6:00 P.M., which correspond to the local hours of the installation, Mondays through Fridays, excluding holidays observed at the installation. An alternate principal period may be designated by mutual agreement.

When remedial maintenance service is requested during the principal period of maintenance or extension thereof, and actual work is required by the customer to begin outside such period, no additional charges shall be applicable during the first hour that such service is actually performed.

Comprehensive Maintenance (Cont'd)	When remedial maintenance service is requested during the principal period of maintenance and the customer authorizes the work to continue to completion beyond such selected period, no additional charge shall be applicable until the manhours of work performed outside the selected period exceed the time from the request until the end of the selected period. Remedial maintenance service requested outside of the principal period of maintenance will be charged at the prescribed rate. When the customer's installation is outside a 25 mile radius of a Systems Engineering Laboratories Service Center, a travel charge at the prescribed rate per mile will apply to the round trip distance between the geographic limits of the applicable service area and the customer's location. Local service will be provided at the customer's request at the prescribed rate. The customer, by giving 30 days written notice to SEL, may extend the principal period of maintenance in the time increments and for the charges shown in the price schedule. The percentage is computed on the total monthly maintenance rate.
Time and Material	Time and material or per call maintenance is recommended for short duration maintenance requirements. It is primarily intended for those customers who have trained maintenance personnel and a spare parts complement.
Local Service	When the equipment to be serviced is located within 25 driving miles of a Systems Engineering Laboratories Service Center, service will be provided at the prescribed rates.
Remote Service	When equipment to be serviced is located beyond 25 miles of the nearest Systems Engineering Laboratories Service Center, service shall be provided at the prescribed rates.
RECOMMENDED TEST EQUIPMENT	
Oscilloscopes	Tektronix Model 7904 500 MHz Oscilloscope
Plug In Options	1 each model 7B92 Dual Time Base 500 MHz 1 each model 7B53A Dual Time Base 100 MHz 1 each model 7A12 Dual-Trace Amplifier 1 each model 7A18B Dual-Trace Amplifier dc-to-80 MHz 1 each model 7A13 Differential Comparator Amplifier 2 each model P6053B dc to 250 MHz 10:1 6 Feet 2 each model P6063A dc to 200 MHz 1:1, 10:1 Selectable 6 Feet 2 each model P6055 Adjustable CMRR 10: 1 3.5 Feet Optional mode P6045 FET Probe Package 1 each model 204-2 Scope-Mobile will hold 5-spare plug-ins and has accessory storage drawer.
Alternate	Model 485 350 MHz Oscilloscope 2 each model P6053B dc to 250 MHz 10:1 6 Feet 2 each model P6063A dc to 200 MHz 1:1 Selectable 6 Feet 1 each model 200-1B Scope-Mobile
General Comments	Model 7904 is very versatile. The nearly automatic triggering and CRT readout of plug-in gain and speed settings greatly reduce errors. Optional plug-ins that provide transistor checking, digital multimeter with direct temperature reading, and a Universal Counter/Timer may be added to enhance the unit's

General Comments (Cont'd)

usefulness. Most Dual-Trace oscilloscopes with a band width of 150 MHz or greater are suitable for the digital troubleshooting function. The Model 485 is recommended for use with digital logic and the Model 7904 is recommended for use with sensitive analog input circuitry.

PRECISION METERS

Hewlett Packard

1 each Model 3460B Digital Voltmeter

1 each Model 3461A ac/ohms Converter dc Preamplifier

Alternate

John Fluke 335A
Precision Null-Balance Differential Voltmeter that may also be used as a precision source.

General Purpose Multimeters

Triplett 630
Simpson 260-5P

Special Tools

- Circuit Card Insertion/Extraction Tool SEL 2187
- Test Adapter Kit Model 2189
- Wire Unwrap Tool No. 30
  Gardner-Denver Co., No. 505084-484
- Wire Stripping Tool
  Ideal Industries, No. 45-181
- Stripping Blade for 30 AWG
  Ideal Industries, No. L7625
- Wire Wrap Gun-Battery Powered
  Gardner-Denver Co., No. 14R2
- Wire Wrap Bit 30 AWG
  Gardner-Denver Co., No. 507063
- Wire Wrap Sleeve 30 AWG
  Gardner-Denver Co., No. 500350
- Integrated Circuit Test Clip
  API Instruments, No. 923698 (14 pin),
  No. 923700 (16 pin)
- 50-Pin Ribbon Cable Assembly (extension)
  SEL 144-100431-012
- Connector Extraction Tool
  (Ribbon Cable Connectors
  3M Company, No. 3438

MAINTENANCE AREA

The maintenance area is used primarily as a storage area for tools, test equipment, prints, and spare parts and as a work station for the off-line repair of peripheral units, instruments, printed circuit cards, etc. A traffic-free, uncluttered area approximately 10 feet x 10 feet is suggested (8 square feet per 100 square feet of computer floor space, minimum of 100 square feet is recommended). The area should have good lighting and convenient access to the computer equipment. The various items that go into the maintenance area as shown in figure 5-1 include:

- A 4-or 5-drawer file cabinet for prints, etc.
- A 1 x 5-foot shelf for instruction books and test equipment.
- A 5-foot (minimum) workbench with a durable, non-conducting working surface.

MAINTENANCE AREA (Cont'd)

- A rubber floor mat that extends the full length of the workbench.
- A minimum of three duplex, grounded 115 Vac outlets.
- A No. 6 AWG (minimum diameter) solid copper ground bus stretched tightly just above, and the full length of the workbench. The bus should connect to ac safety ground by clamping or silver-soldering it to the outlet boxes.
- A spare parts storage area.
- A parking space for the oscilloscope cart.

If possible, the maintenance area should also include a standard office type desk and chair.

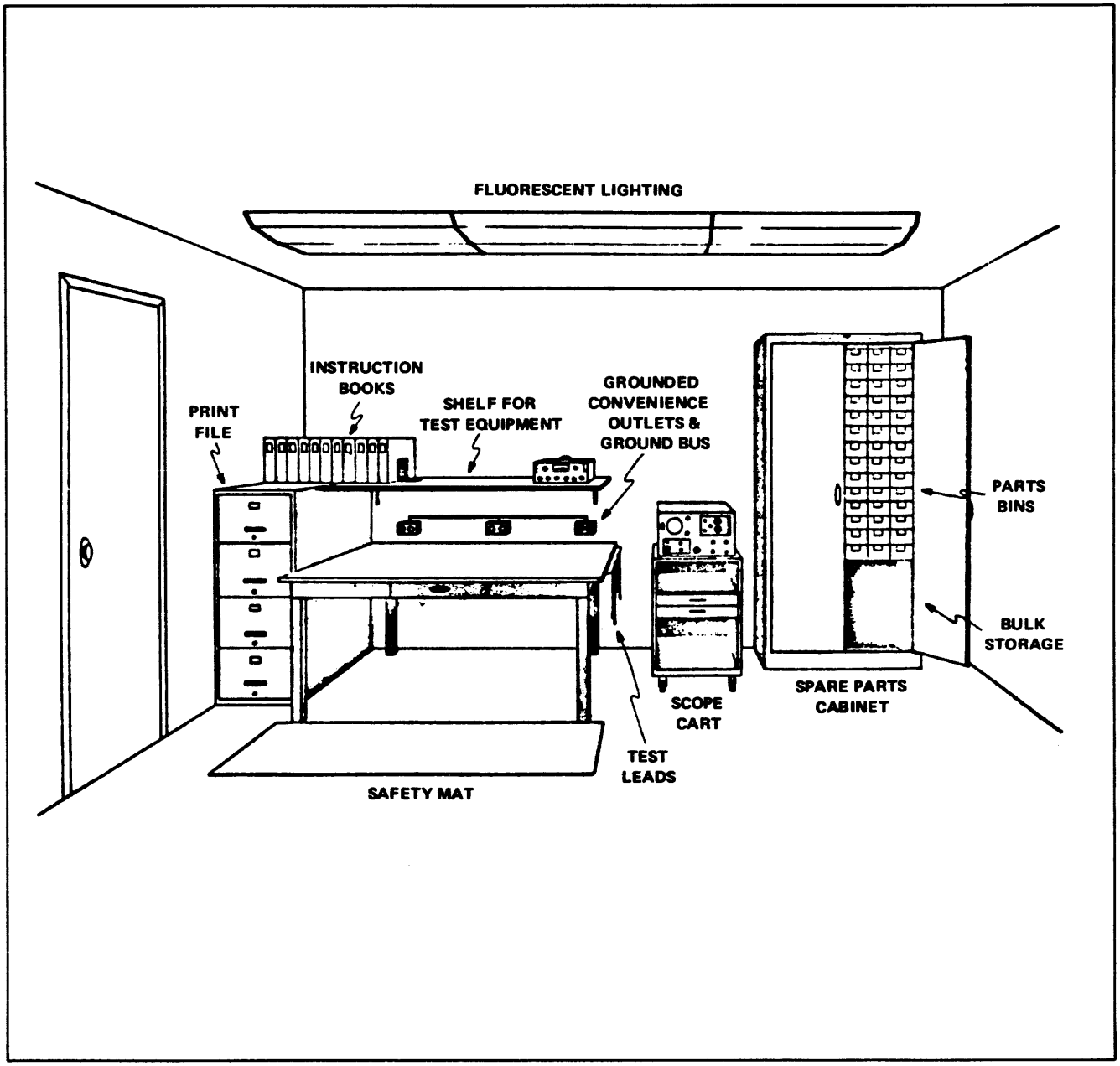


Figure 5-1. Desirable Maintenance Area

TRAINING

INTRODUCTION

Obtaining peak performance from your computer system requires thoroughly trained programmers, engineers, and technicians. To provide the training vital to the efficiency of these people, SEL has developed courses of instruction on how to use, program, and maintain SEL computers. The courses are conducted at SEL's training facility in Fort Lauderdale, Florida, and are prepared and executed by a staff of professionals in the computer science field.

A BLEND OF CLASSROOM AND LABORATORY INSTRUCTION. Courses are based on laboratory sessions, class discussions, and hands-on equipment experience. Participants in software courses, for example, are familiarized with the hardware and software aspects of the computer during lecture-conference style classroom sessions. By performing actual programming tasks, they gain full command of the programming languages involved. Maintenance courses similarly instruct the trainee by blending classroom lectures with on-site work experience. Since it is vital that maintenance trainees acquire proficiency in the use of servicing techniques, laboratory sessions are devoted to operating and troubleshooting the equipment.

Computers and related equipment are installed at the SEL training facility. In addition, the SEL computer center with its full range of computers and peripherals is available for laboratory sessions.

ALL COURSE MATERIALS SUPPLIED BY SEL. Everything needed for course attendance is supplied by SEL. Course materials are keyed to the content of each course and include hardware, software, and reference manuals. Specially prepared training manuals are also provided to aid the student in comprehending complex hardware and software concepts. Student notebooks are supplied, and handout materials related to maintenance and programming are distributed to the trainees for future reference.

ENROLLMENT. The capability of each class is limited, an early enrollment is advisable to ensure acceptance in the course desired. Telephone inquiries may be made; however, it is requested that all applications be made in writing.

Course descriptions and application forms can be obtained by contacting the SEL Training Manager at:

Systems Engineering Laboratories, Incorporated
6901 West Sunrise Boulevard
Fort Lauderdale, Florida 33313

Phone: (305) 587-2900

SPECIAL COURSES. In addition to the regularly scheduled courses, SEL's training staff is prepared to conduct courses to meet your special training requirements. Also, courses may be conducted at your facilities when it is not economically feasible to transport a large group to Fort Lauderdale. For additional information regarding special training capabilities, contact the SEL Training Manager.

FORT LAUDERDALE TRAINING CENTER

Training courses are available covering software use or maintenance of SEL Standard Computer Products. For active product lines, these courses are regularly scheduled and conducted by a full-time staff of qualified instructors at the Fort Lauderdale, Florida Training Facility.

Personnel may attend any of the standard scheduled courses at the prescribed rate. Price is determined for the full course duration, whether or not the trainee has been in full attendance.

FORT LAUDERDALE TRAINING CENTER (Cont'd)

All necessary training materials and texts will be provided. The customer is responsible for all personal expenses, such as trainee travel, living expenses, per diem local transportation, etc.

Note

Contact the SEL Training Manager for up to date price and details on desired course.

Mail/Phone

During your stay, you can receive mail directed to you at:

(Your name followed by your company's name)

c/o Systems Engineering Laboratories, Incorporated
6901 West Sunrise Boulevard
Fort Lauderdale, Florida 33313
Attention: Technical Training

You can be reached by phone anytime between the hours of 7:45 a.m. and 6:00 P.M. -- Monday through Friday -- through the switchboard operator. Phone (305) 587-2900. We request, however, that incoming calls while classes are in session be limited to those of an urgent nature.

FIELD TRAINING

Standard courses may be conducted at customer facilities for convenience when this is desirable. These courses will be identical to the course conducted at Fort Lauderdale and are quoted at the prescribed rate per class week, plus round trip airfare from the Fort Lauderdale area for the instructor(s). Class size is limited to (10) trainees. The customer furnishing a computer system for demonstration purposes is desirable.

SPECIAL TRAINING

Special courses pertaining to equipment not listed as standard, or courses tailored to a customer's specific request, can be arranged to satisfy any specialized training that may be desired. These courses ordinarily incur additional charges for preparation efforts and documentation.

On-site or special courses and scheduling are coordinated with the Customer Services Technical Training Section.

GENERAL INFORMATION

All courses are designed to teach experienced computer personnel how to use and maintain SEL computer products. While courses review concepts, mathematics, and logic systems, they are not intended to teach basic programming, electronics or computer technology. There is never any attempt to teach a skill.

All training is scheduled by the Customer Services Technical Training Section on a bi-annual basis for six month periods. These schedules are distributed in October for the period covering January through June, and in April for the period covering July through December.

Schedules are based on training requirement loads and are subject to change without notice.

If additional class scheduling is desired by the customer, the Customer Services Technical Training Section will attempt to satisfy the requirement. A class will ordinarily not be scheduled if less than five (5) students are enrolled. A customer who desires to schedule a standard course and cannot supply the minimum number of trainees may have a schedule arranged for his convenience.

Class Hours

At 8:00 a.m. on the first day of classes, trainees are requested to check in with their instructor at the classroom facility. Normal classroom hours are from 8:30 a.m. until 4:40 p.m., Monday through Friday. Fifteen minute breaks are provided in the morning and afternoon as well as a one-hour lunch period at noon. Occasionally, laboratory sessions involving the use of computers may be held during the evening.

Holidays

No clases are held on the days listed below. When a holiday falls on a weekend, no classes are held on either the preceding Friday or the following Monday.

New Year's Day	Independence Day
Good Friday	Labor Day
Memorial Day	Thanksgiving
	Christmas

Accomodations

Students must provide their own accommodations. A list of accomodations within easy reach of the training facilities has been compiled and attached to the initial Training documentation issued each student. Some of these are available at discount rates. These rates should be double checked when reservations are made.

Transportation

Students must provide their own transportation. Use of a rental car is advised since public transportation facilities are limited.

DOCUMENTATION

The customer documentation provided for the SEL 32 Computer and Peripheral Series by SEL consists of hardware and software manuals, described in the Bill of Material Section. The types of hardware manuals provided are Design Manuals, Operator Manuals, Reference Manuals, Technical Manuals, and Drawings Manuals. Software Reference Manuals and Program Description describe the software for SEL 32.

All manual content and formatting are patterned from MIL-M-729-A, MIL-M-4410 and MIL-M-5474 standards. Other than the Technical Manuals, which are two volume packages, all manuals are single-volume, standard size (8-1/2 x 11"). The Drawings and Firmware Manuals are larger (11 x 17") than the standard size.

SECTION VI

STANDARD ACCEPTANCE TEST

INTRODUCTION

The SEL 32 Acceptance Test demonstrates the performance and features of the SEL 32 software and hardware by executing applicable hardware programs and a software acceptance demonstration test.

Each test procedure describes the preparation of the equipment, loading and initiation of the programs, and the results to be obtained. The satisfactory conclusion of these tests is considered proof of system operation in conformance with SEL's technical specifications.

If a test cannot be performed, the acceptance test is halted until the malfunction is determined and the problem rectified. The malfunction and its resolution will be noted. Testing will resume with the first test of the equipment or software in which the malfunction occurred.

The Acceptance Test and system acceptance will take place at SEL's facilities in Fort Lauderdale, Florida, prior to shipment of the system. This test will be witnessed by representatives of the Customers Service Department. In addition, the customer may elect to witness these events. After the system is installed at the customer's facility, the system will be demonstrated to be fully operational using the same procedures previously employed in the Acceptance Test at SEL's facilities.

The Acceptance Test will consist of the following:

- Static Test
- Dynamic Test
- Software Demonstration

STATIC TEST

The Static Test consists primarily of visual inspection to verify that the system has been built according to good manufacturing standards and in accordance with SEL's Workmanship Standards and that all hardware items are built to good manufacturing standards and are interconnected properly.

A visible inspection will be made to ascertain that:

- A list of the major components of the mainframe, including model number, serial number, description, and quantity delivered is correct.
- A list of all peripherals delivered including the model number, serial number, description and quantity.
- All hardware tests to be performed are identified.
- All software tests to be performed are identified.
- All test equipment to be used is identified.
- All documentation required in support of the Acceptance Demonstration is identified.

DYNAMIC TESTS

The Dynamic Tests will demonstrate the operational capability of each portion of the system with the delivered software.

Preliminary set-up involves verifying that the system is connected according to the block diagram, applying power to the system, and verifying that all units have been put into operational status.

The Dynamic Tests are comprised of two major categories:

- Computer Mainframe Test
- Peripheral Test

COMPUTER MAINFRAME TESTS

Unless otherwise stated, the system tests are performed sequentially without altering the configuration between tests.

Mainframe Diagnostic

The SEL 32 Mainframe Diagnostic will provide verification of a correctly functional mainframe. The Mainframe Diagnostic is divided into two parts because of core limitations. The overall test, though split into two parts, will test logic upward from relatively simple logic blocks to advanced logic blocks.

The diagnostic consists of a series of instruction tests, each test containing several subtests, and each subtest being progressively more demanding on the mainframe. Execution of every subtest is monitored by the control portion of the diagnostic. Part two tests the arithmetic unit, starting with add and subtract instructions and advancing to multiply and divide instructions and indexing and multilevel addressing.

Memory Diagnostic

The Memory Diagnostic will verify the correct functioning of the Computer Memory. The diagnostic will check out all memory modules on the computer. The amount of available memory to be tested will be determined by the program by the nonpresent Memory Trap. The diagnostic consists of 11 separate tests which systematically write, read, and verify numerous bit patterns, including worst-case patterns, to fully exercise all available memory.

Priority Interrupt And Trap Test

This diagnostic will verify the correct operation of all available mainframe interrupts, using all interrupt instructions. All available interrupts and special traps are tested with minimum user intervention. External interrupts will also be tested using an optional section of the diagnostic which checks external triggering of the interrupts.

Memory Protect Diagnositc

This diagnostic will verify the correct operation of the memory protect logic. The diagnostic consists of three test sections. Section 1 tests the Privileged mode of operation with a Protect Register Test. This program will test transfers to and from all computer registers and all protect registers. Section 2 tests the Privileged Mode and Unprivileged Mode with a Page Protect Test and a TRP Instruction Test. The Page Protect Test checks all combinations of the protect state, and the page protect bits are set up and tested. The TRP instruction, used to change the contents of a protect register, is tested to verify that a privilege violation occurs when the instruction is executed under the proper conditions. Section 3 tests the Unprivileged Mode with the Page Protect Test and the Privileged Instruction Test. The Privileged Instruction Test verifies that a privilege violation occurs under the proper condition.

KSR-33 Typewriter Test

This diagnostic will verify the correct functioning of the KSR-33 keyboard printer and associated logic. The diagnostic consists of six tests:

- Output Test
- Keyboard Printer Turnaround
- Unit Function Codes Test
- Rotating Pattern Test
- Character Test
- Pre-Test to test the KSR Interrupt Structure

Floating-Point Arithmetic Diagnositc

This diagnostic will verify the correct functioning of the floating-point Firmware. All floating-point instructions will be tested with random numbers.

PERIPHERAL TESTS

The peripheral equipment diagnostics are capable of running singly or in a system test environment under the control of the Diagnositc Executive Program.

Diagnostic Executive Program

The Diagnostic Executive Program (DEP) is a control program designed to allow for concurrent interrupt driven execution of any number of peripheral diagnostic programs on a SEL 32 Computer, limited only by core memory size and peripheral availability. The DEP provides many features not found in conventional stand-alone test programs or diagnostics:

- All diagnostics are relocatable and load in the same manner.
- All diagnostics have basically the same Option settings for error control.
- All diagnostics start and stop in the same way.
- All errors are reported in the same manner through the control program.
- Diagnostics perform their own input/output functions to the device under test, providing maximum flexibility to the diagnostic.
- Diagnostics may control input/output functions simultaneously.
- A wide variety of dynamic user services are available.
- Operator intervention facilities are available.

Card Reader Or Card Reader/Punch

The Card Reader Test and the Card Reader/Punch Test will verify the correct functioning of the device being tested. Each device is fully exercised by a a series of tests which read and/or punch data patterns. The diagnostics can be optionally controlled by the operator through Optional settings. Error messages are typed on the keyboard/printer by the program.

Line Printer

The Line Printer Test will verify the correct functioning of the line printer and associated logic. The diagnostic includes an On-Line Character Test, Rotating Pattern Test, Multi-Character Array Test and a Vertical Format Test. All tests are monitored for correct operation of the Service Interrupt signal and Transfer Control Word. Appropriate error messages are typed on the console keyboard. The operator will visually inspect the printed output for additional errors not detectable by the diagnostic program.

Disc

The Disc Diagnostics will verify the correct functioning of the moving head and fixed head disc drives and associated logic. The diagnostic consists of numerous tests to fully test the capabilities of the device and controller. These tests include writing and reading each disc sector using a unique sector identification number. The operator can optionally control the testing by setting Options. Appropriate error messages are typed on the console printer by the program.

Magnetic Tape System

The Magnetic Tape Diagnostics will verify the correct operation of the 7 and 9-channel magnetic tape drives and controllers. The tests include the read/write and other capabilities of the device. Optional settings by the operator will vary the testing procedure. Error messages are typed on the console printer by the program.

SOFTWARE DEMONSTRATION

The Software Acceptance Tests will demonstrate the software as applicable to the delivered system. The Software Tests are comprised of three major categories as follows:

PROCESS CONTROL EXECUTIVE

The Acceptance Demonstration for the Process Control Executive Acceptance Demonstration Test will demonstrate the basic functional capabilities of SEL's Process Control Executive (PCX) software. These capabilities include:

- Analog and Digital scanning and conversion
- Sensor reasonability checking

PROCESS CONTROL EXECUTIVE (Cont'd)

- Limit Checking
- Alarming
- Trending
- Sequence of Events recording
- Logging
- Interprogram Communications
- Man/machine interface by both operator's and programmer's consoles
- Applications programs, including plant logs, performance calculations, core operating limits calculations, etc.
- Power Fail/Restart procedures
- On-Line and Off-Line generation of the system data base

REAL-TIME MONITOR

The Real-Time Monitor Acceptance Demonstration Test will demonstrate the basic functional capabilities of SEL's Real-Time Monitor (RTM) software. These capabilities include:

- System Generation and Start-up
- Operator Communications
- System Processors
- Program Cataloging
- Task Activation
- Multi-Programming
- Roll-Out Features

BATCH PROCESSING SYSTEM

The Acceptance Demonstration for the Batch Processing System (BPS) will be run only if the system to be delivered does not include the Real-Time Monitor.

The Batch Processing System Acceptance Demonstration Test demonstrates the basic functional capabilities of BPS. These capabilities include:

- Console Communications
- Job Control Language
- Assignment Services
- Dynamic Load Services
- Input/Output Services
- Assembler
- Macro-Assembler
- Debug Processor
- Library Generator
- Media Conversion
- Source Update