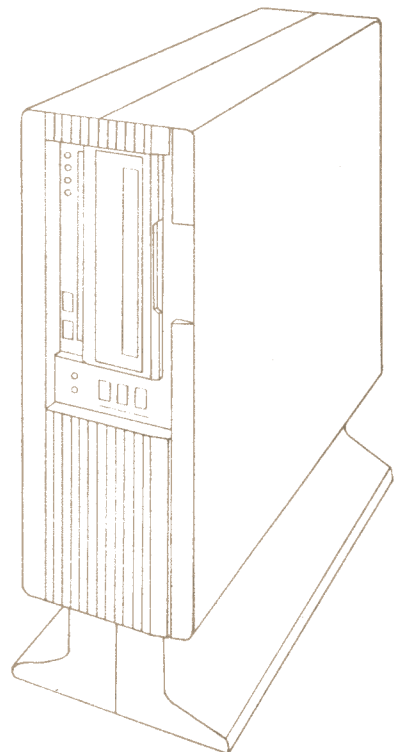




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TECHNICAL SUMMARY



PowerFrame

**Ford
Higgins Ltd.**

Technical Summary

PowerFrame
Microcomputer Systems

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RSX-11M+	FMS	RMS-11	RESORC
RSTS/E	SORT-11	DMS-500	ODT
ULTRIX	DCL	DSORT	SIPP
11/23+	BASIC-PLUS	PIP	KED
11/73	RSX	DUP	AUTOPATCH
LSI-11 BUS	DECnet/E	DIR	USEP
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TECHNICAL SUMMARY

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OVERVIEW

1. Introduction

The PowerFrame is a low-cost multi-tasking computer system that meets the needs of today's small business market. There are several attributes of the PowerFrame other than its affordability that make it attractive to the customer:

VARIABLE ARCHITECTURE

The PowerFrame is unique in its adaptability to a customer's present as well as future needs. This flexibility is made possible by the fact that the PowerFrame presently runs five popular operating systems with additional O.S.'s in the works. Four of the present operating system options are in use around the world on Digital Equipment Corporation's popular PDP-11 mini-computers. These operating systems are as follows:

RT-11

RSX-11M

RSX-11M+

RSTS/E

The customer can convert from any one of these O.S.'s to any of the others by simply switching the disk cartridge. The customer's own programming languages, compilers, and other media can be transferred at the factory to the disk cartridge containing the operating system before being shipped to the customer. This service is available for a nominal fee.

The hardware to support these operating systems is based on either of two Central Processing Units. These CPU's are:

11/23+
11/73

To switch from one of these CPU's to the other only requires changing the CPU board (see chapter 2 for a description of the CPU board).

For those customers who wish to run the UNIX operating system, the answer is a Motorola 68010-based PowerFrame system running UNIX System 5. Again, if the customer wishes to change from UNIX to one of the DEC operating systems or vice versa, all that need be done is to switch CPU boards and disk cartridges.

The PowerFrame power supply also exhibits variable architecture in the fact that it has international input voltage capability allowing it to be used in any country.

EXPANDABILITY

In keeping with the adaptability of the architecture, the ingenious design of the PowerFrame allows the customer to expand the system to suit the user's needs. Dynamic RAM, mass storage, and number of user ports can all be increased by adding additional memory boards device handlers, and expansion cases. Following are the present expansion capabilities:

Memory - 256K Bytes up to 4 Megabytes.

Mass Storage - 40 Megabytes up to 200 Megabytes.

Ports - 2 up to backplane(s) capacity.

Cases - Single PowerFrame expandable to double-wide.

See the following section on configuration options for the details of expandability.

1.1 Configuration Options

The PowerFrame supports many different configurations offering a wide range of memory, disk storage, and port structures with each of the three CPU's.

1.1.1 Minimum Configuration

The minimum configuration for any of the three PowerFrame models is as follows:

- Single PowerFrame case
- One disk unit with 20MB fixed storage and 20MB removable cartridge.
- 256KB dynamic RAM
- One console port and one auxiliary available for use with most asynchronous serial devices.

1.1.2 Upgraded Configurations

The above four configuration items may be upgraded in the following ways:

- An expansion module can be added to form a dual-wide system to accommodate additional fixed disks, or two expansion cases may be added to hold the additional disks or additional distribution panels.
- With the expansion case, the system supports the minimum disk configuration plus an 80MB fixed disk in the expansion module.
- Memory can be added in increments up to 4MB.
- Ports can be added eight at a time (8 per multiplexer board) up to the card cage(s) capacity.

1.1.3 Restrictions

The above configurations are supported in any combinations up to the point where the card cage is filled to capacity. Also, there is a point where prudence dictates a maximum configuration. For example, a system with an 11/23+ processor and a half Megabyte of memory will not perform well with 20 different jobs running.

A single backplane contains eight quad-wide slots. Each card takes up either a half slot or a full slot. A card that takes

up only half a slot is possible because of dual-wide cards.

11/23+ CPU board - 1 slot. This board includes the two system I/O ports.

11/73 CPU board - Half of a slot. The two system I/O ports are on the Serial I/O board which takes a half slot.

68010 CPU board - 1 slot. The system ports are on the Serial I/O board.

Memory Boards - 1 slot for each MB or fraction of MB of memory (4MB maximum).

Multiplexed I/O Board - One half slot for each 8-port dual-wide card. These are user ports.

Serial I/O board - Half slot. This board contains the two system ports for use with the 11/73 and 68010 CPU boards.

Disk Controller Board - 1 slot.

The PowerFrame is thus almost unlimited in configurations across five separate operating systems. The customer should feel free to utilize the factory's technical expertise in evaluating needs and cost effectiveness versus performance specifications to arrive at the most suitable configuration.

1.2 Performance

That the PowerFrame is a high performance system can be summed up in the following manner:

PERFORMANCE THROUGH TECHNOLOGY

PERFORMANCE THROUGH ADAPTABILITY

PERFORMANCE THROUGH TECHNOLOGY

The PowerFrame employs the latest technology in each of its variations. The 11/23+ and the 11/73 CPU are at the forefront of minicomputer technology. The Motorola 68000 family of microprocessors is the latest in VLSI technology and is being employed in new microprocessor-based systems throughout the industry. The PowerFrame memory board employs the latest in 256KB RAMs. The list goes on, but suffice it to say that the PowerFrame is an integration of "state of the art" throughout.

PERFORMANCE THROUGH ADAPTABILITY

It would be difficult to overstate concepts like "flexibility", "adaptability", and "variable architecture" when speaking of the PowerFrame. The ability to change operating systems at will, the ability to change processors to meet changing needs, the ability to add memory, storage, ports, etc. is a definition of performance in itself to today's hardworking company executive determined to stay in front of the competition.

See the Appendix for the performance specifications for the various PowerFrame components. There are several important points concerning performance that should be noted here:

- All three PowerFrame CPUs are equipped to address up to 4MB of memory
- The 68010 CPU running UNIX has dual port memory addressing, allowing the CPU to access memory over a dedicated bus while the Q-bus is busy with Direct Memory Access transfers or other non processor requests (NPR).
- The 68010 running UNIX supports a "shared text" capability, allowing multiple users to share the text segment of a program without making a copy of it for each user.
- Average disk access time with the PowerFrame disk drive is less than with than the current standard PDP-11 drives. This quicker access time yields increased performance over current PDP-11 systems.
- The RSX-11 operating system will perform better than the others when used in an environment requiring execution of multiple programs concurrently.

- The RSTS/E operating system will perform better than the other O.S.'s in a timesharing or batch processing environment.
- The RT-11 operating system will perform better than the others in a single user environment.

1.3 Special Systems Group

The PowerFrame developers are dedicated to the concept of adaptability through variable architecture. To this end, the factory has implemented a special systems development group that will tailor a system to a customer's needs if one of the standard systems will not fill the bill. For example, plans are already underway to develop a VAX/VMS based system. Moreover, as a general philosophy the PowerFrame will strive to offer the customer the adaptability to implement as many commercially available products as possible on the PowerFrame. For example, plans are being implemented to support new disk controllers, disk drives, and operating systems.

Printed Circuit Boards

The following chapters summarize the PowerFrame's printed circuit boards (PCBs). Following are the various boards comprising the PowerFrame electronics:

CPU Board - one of three different boards depending on the PowerFrame model.

Memory Board(s)

Disk Controller Board(s)

Multiplexed I/O Board(s)

Serial Line Interface Board Backplane(s)

The PowerFrame comes in three models, the 2340, 7340, and 6840. The main distinction in these systems is the processor board. The 2340 uses a 11/23+ CPU; the 7340 uses the 11/73 CPU, and the 6840 uses the 68010 CPU.

11/23+ CPU BOARD

The 11/23+ CPU board is a quad wide board occupying one slot in the card cage. The two system serial line ports are located on this board. Following are the technical specifications for this board.

- The FULL PDP-11/34A INSTRUCTION SET and the EXTENDED INSTRUCTION SET (EIS) are standard on the 11/23+.
- Memory is WORD AND BYTE ADDRESSABLE.
- EIGHT INTERNAL REGISTERS are available in User Mode.
- STACK PROCESSING provides a logical means for code to jump to sub-routines and pass-arguments and then return in an efficient manner.
- DIRECT MEMORY ACCESS (DMA) offers maximum usage of the standard Q-Bus.
- An 18-bit ODT (Octal Debugging Tool) CONSOLE EMULATOR allows debugging to be performed from the board level.
- A MEMORY MANAGEMENT UNIT (MMU) with 22-bit addressing, is capable of addressing a full 4MB . This feature allows for various memory configurations beyond the basic 256KB minimum. The MMU provides address relocation, extending the physical address range to 22 bits. It includes unique features such as "segmentation" (dividing large segments of program memory into smaller, more efficient segments) and "protection" (the ability to control and restrict access to a memory segment).
- TWO SERIAL LINE UNITS (SLU) on the processor board provide ports for the console terminal as well as an additional device. Typically, this extra port is used for a printer, thus, freeing up a DZ line for users. These serial ports provide the 11/23+ with an EIA interface which is RS-232-C and RS-432 compatible.
- BOOT AND DIAGNOSTIC ROMs provide extra security at system start-up time. The bootstrap procedure first tests memory before transferring control to the boot device. If any problems are detected the system halts and displays the address of the error register from which a precise analysis of the halt may be made.
- The 11/23+ has DESIGN ENHANCEMENTS which permit greater

execution speeds, multi-level interrupts, full memory management, and the floating point instruction set. The 11/23+ represents state-of-the-art N-MOS technology and printed circuit design.

- The 11/23+ CPU is contained on TWO LSI CHIPS (control and data) which reside on a single 40-pin carrier (a dual in-line package). The Memory Management Unit (MMU) is contained on one LSI chip which also resides on a 40-pin carrier. The 11/23+ board contains sockets for these two carriers, plus three extra sockets which are reserved for the Commercial Instruction Set (CIS) and/or Floating Point Set (FPS) options.

- Because of its INTERNAL BUS STRUCTURE, the architecture of the 11/23+ is highly expandable. The control and data chips communicate with each other, as well as with the external 11/23+ logic, over the Micro Instruction bus (MIB) and Chip Data and Address Line (CDAL) bus. 11/23+ logic interfaces these chips to the Internal Data and Address Line (IDAL) bus and the external Extended LSI-11 bus (Q-Bus). The Extended LSI-11 bus interface supports four full megabytes of memory. The IDAL bus provides additional loading capacity on the chip set bus.

- The 11/23+ INSTRUCTION SET offers a wide choice of operations and addressing modes. The instructions allow byte and word addressing in both single- and double-operand formats. Several operations can be performed with a single instruction using double-operand instructions. The instruction set also contains a full set of conditional branches to eliminate excessive use of jump instructions.

- Forty-six FLOATING POINT INSTRUCTIONS are available as a microcode option in the 11/23+ processor to supplement the integer arithmetic instructions in the basic instruction set. The Floating Point Instruction Set provides both single-precision (32-bit) and double-precision (64-bit) operands, and conserves memory space by executing in microcode instead of software.

- The COMMERCIAL INSTRUCTION SET (CIS), a microcode option, adds character string instructions to the basic 11/23+ instruction set. These character string operations implement functions of commercial data and text processing applications. CIS microcode resides in six MOS/LSI chips which are mounted on a single double-width 40-pin carrier.

- The LINE FREQUENCY CLOCK provides the system with timing information at fixed intervals which are synchronized with the line frequency of the user's input power. Although the line frequency clock is part of the processor board, a remote clock

may also be selected by changing jumpers on the processor board.

- 4-LEVEL VECTORED INTERRUPTS allow a higher-level interrupt request to interrupt a lower-priority service routine. This scheme eliminates the need for interrupt polling, leaving the processor free to complete program processing

- As mentioned before, MEMORY IS EXPANDABLE from 1/4MB through 4MB. Our memory is state-of-the-art technology. It also features an on-board Control and Status Register (CSR), on-board parity error LED flag, and extensive pre-installation burn-in testing.

- The 11/23+ microcomputer is designed to increase SYSTEM PERFORMANCE and provide efficient backplane utilization.

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11/73 CPU BOARD

The 11/73 CPU board is a dual-height processor module designed for use in high-speed, real-time applications and multi-user, multi-tasking environments. It occupies a half slot in the card cage. The two serial I/O ports are located on a separate dual-height board. The two boards together occupy one quad backplane slot. Some of the CPU's features include:

- The 11/73 processor offers FULL 22-BIT MEMORY MANAGEMENT.
- CONSOLE EMULATION allows interactive communication over the console terminal to the system operator for bootstrapping the system.
- The MICROCODE OCTAL DEBUGGING TOOL (ODT) provides a board-level means for diagnosing bootstrap failures as well as undesirable conditions encountered at the application and operating system levels. The micro ODT code is accessed with the processor on/off switch. Optionally, the Break key may be jumper-enabled to perform the same function.
- LAYERED SOFTWARE PROTECTION may be implemented due to the three protection modes. Each mode is separately managed by memory management, allowing each mode access to different sections of main memory. Each section may have different access protection rights. Separate system stack pointers, offering additional isolation, are used by each mode. The protection modes are organized so that a higher protection mode can always enter a lower protection mode, but a lower protection mode can never enter a higher protection mode. Kernel mode has full privileges and can execute all instructions. The two lower privileged modes, supervisor and user, cannot execute instructions which would compromise the integrity of the system.
- The 11/73 can address up to 4MB of MAIN MEMORY.
- The 11/73 interfaces to the extended LSI-11 bus.
- The 11/73 supports DMA transfers, which are allowed on the extended bus. The 22-bit extended LSI-11 bus is fully downward compatible with the standard LSI-11 bus. Optionally, block mode DMA may be configured into a system that employs block mode memory and block mode peripherals controllers.

- The 11/73 offers an 8 KB WRITE-THROUGH DIRECT MAP CACHE (set size one, block size one). The cache acts as a high speed buffer between the processor and main memory. It is transparent to all programs. The data stored in the cache represents the most active portion of the main memory being used. The processor only accesses main memory when data is not available in the cache. Extremely high cache hit ratios are not uncommon.
- SELF-DIAGNOSTIC LEDs indicate the status of the module and system when the module is powered-up. The LEDs aid in trouble-shooting.
- The 11/73 supports several of the most popular OPERATING SYSTEMS, including DEC licensed RT-11, RSX-11M, RSX-11M+ and RSTS/E.
- Sixteen GENERAL PURPOSE REGISTERS are provided with the 11/73 processor. Only eight are visible to the user at any one time. All of these registers may be used as accumulators, deferred addresses, index references, autoincrement, autodecrement, and/or stack pointers.
- SYSTEM CONTROL REGISTERS consist of the processor status word (PSW), program interrupt request (PIRQ), CPU error register, line clock register, and the maintenance register. These registers control system oriented functions.
- A variety of trap, hardware, and software INTERRUPTS are used by the 11/73. Four interrupt request lines allow external hardware to interrupt the CPU on four interrupt levels using an externally supplied vector. Seven levels of software interrupt requests are supported through use of the PIRQ register. Several internally vectored traps are also provided to flag error conditions.
- Complete MEMORY MANAGEMENT AND PROTECTION is available with the 11/73 memory management hardware. It is designed to be a memory management facility for accessing all of physical memory and for multi-user, multi-programming systems where memory protection and relocation facilities are necessary. Memory management also provides the means for assigning memory pages to a user program and preventing that user from making any unauthorized access to pages outside his/her assigned area. This prevents the user from causing any accidental or willful destruction of any other user program or the system executive program.
- The 11/73 processor can perform 16-bit, 18-bit, or 22-bit address MAPPING. In 16-bit mapping there is a direct mapping relocation from virtual to physical address. In 18 bit mapping,

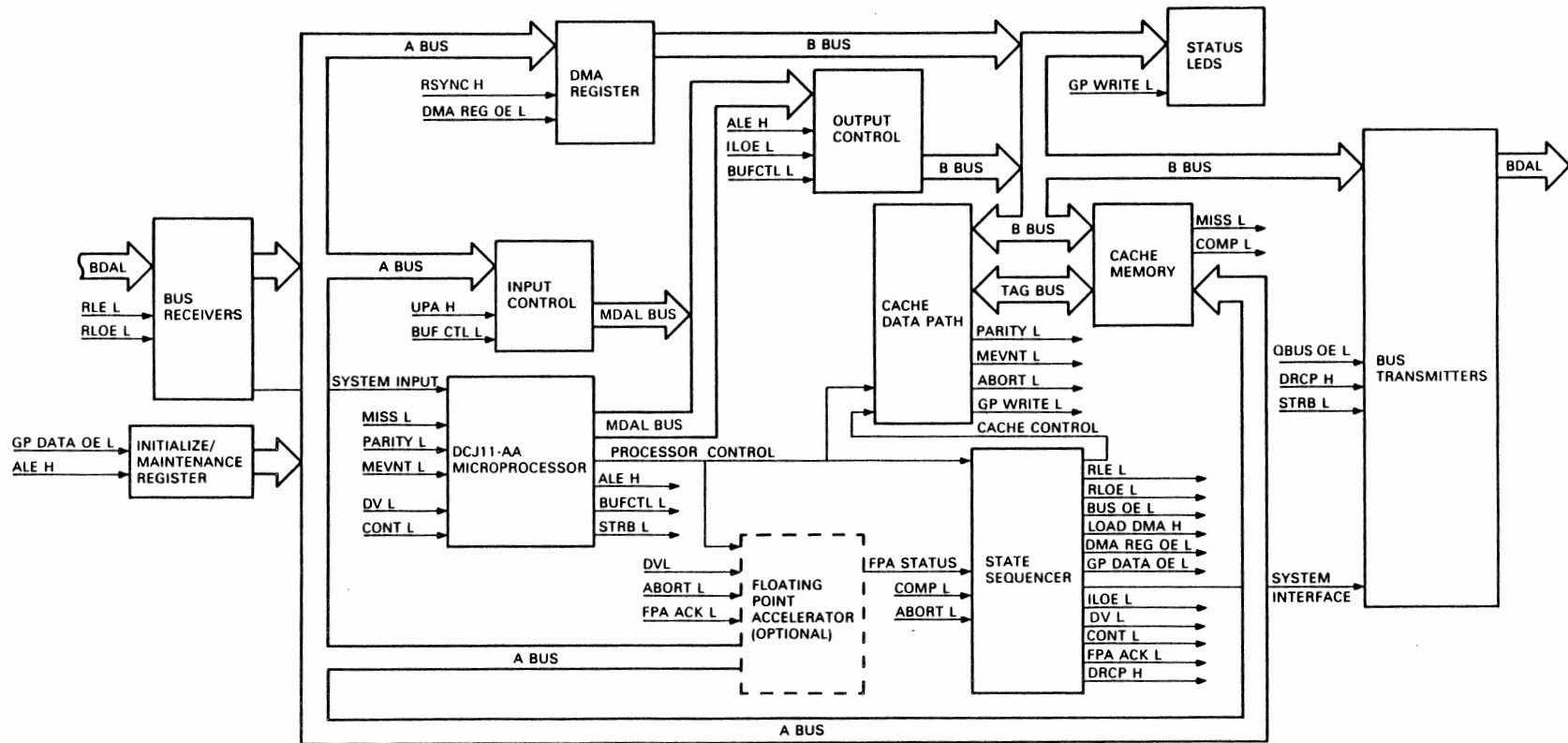
the kernel, supervisor, and user modes are allocated 32K words that are mapped into 128K words of physical address space. 22-bit mapping utilizes a full 22-bit 1/4 Meg of primary memory. The operation of 16, 18, and 22-bit mapping can be used to provide compatibility among other PDP-11 computers. Thus, software developed for ANY PDP-11 can be run on the 11/73 without modification.

- The normal 16-BIT ADDRESS is no longer interpreted as a direct physical address but as a virtual address when memory management is operating. This virtual address contains information to be used in constructing a new 22-bit physical address. Using memory management, memory can be dynamically allocated in pages, each composed of from 1 to 128 integral blocks of 64 bytes.

- In a multi-programming application, MEMORY PAGES may be allocated such that a program appears to have a complete 64K byte memory configuration. Through the use of relocation, a kernel mode supervisory-type program can perform all memory management tasks entirely transparent to a supervisor or user mode program. In this way, a system can use its resources to provide maximum throughput and response to a number of users, each of whom seems to have a powerful system for his/her sole use.

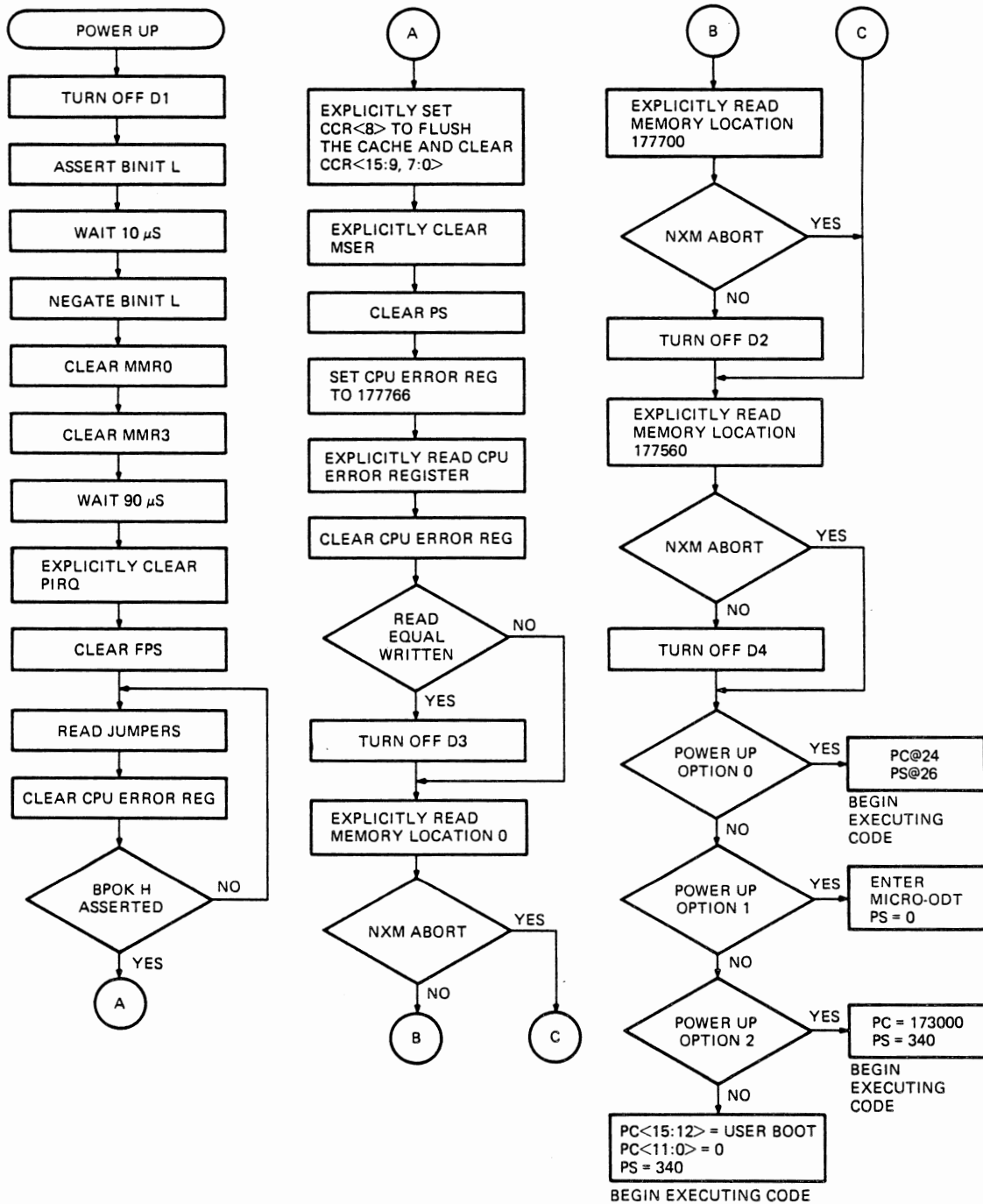
- The 11/73 contains a main memory PARITY ERROR DETECTION mechanism. The cache memory also has a parity error detection mechanism. A parity error in the cache is not considered fatal because the main memory system has a backup copy of the data.

- The FLOATING-POINT INSTRUCTION SET performs all floating-point arithmetic operations and converts data between integer and floating-point formats. It uses the same memory management facilities and similar address modes of the processor. The floating-point instructions can reference the floating-point accumulators, the general registers, or any location in memory.



11/73 Functional Block Diagram

POWER-UP SEQUENCE



KDJ11-A Power-Up Sequence

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M68010 CPU Board

The M68010 microprocessor is a general purpose CPU fabricated on a single chip using high density MOS technology. It takes one full slot on the card cage. The serial I/O ports are located on a separate dual height board. Some of the 68010 board's features include:

- The M68010 CPU offers a 23-bit ADDRESS BUS and a 16-bit DATA BUS.
- CONTROL SIGNALS generated by the decoder/controller logic operate the individual functional blocks on the processor board. Decoder/controller logic permits software control over some of the individual function blocks and detects and reports error conditions.
- MEMORY MANAGEMENT consists of a segment map and a page map. The segment map divides the physical memory of the system into 16 segments, each a maximum of 1 Megabyte in length. It also enforces access protection. The page map provides support for the demand-paged virtual memory operating system, UNIX (licensed by Bell Laboratories), under which the M68010 runs. The page map also helps in managing physical memory.
- EPROM MEMORY includes code for boot-strap and a monitor/debugger. A small amount of RAM is also available for standalone operation.
- A Q-BUS interface is provided for all I/O transactions to optimize efficiency during Q-Bus operations. Peripheral interrupts from the Q-Bus into the M68010 interrupt scheme are translated by a separate interrupt decoder.
- In addition to the Q-Bus, the M68010 also offers the S-BUS, which is a proprietary, high-speed memory channel. A multiplexed RAM addressing scheme, employed by the S-Bus, takes advantage of the RAM chips' design to provide maximum processor/memory access efficiency. Bus arbitration logic controls both the S-Bus and the Q-Bus adapters. Because of the design, both the S-Bus and the Q-Bus may be operated simultaneously under certain circumstances (such as in DMA transfers) for increased performance and throughput.
- The PRINCIPLE DATA PATH is a 16-bit wide bi-directional data path that interconnects most of the functional blocks on the processor. Bi-directional buffers connect the processor data bus

to either the S-Bus or resident data bus lines.

- ERROR LOGIC processes error conditions detected on the CPU board and on the S-Bus memory. When an error condition is detected, the S-Bus write signal and the Q-Bus transactions are inhibited.

- INTERRUPT LOGIC processes interrupt requests from peripheral devices located on the Q-Bus. When the 68010 is interrupted, an interrupt level code identifies the interrupt priority. Interrupt levels range from 1 to 7.

- The MEMORY MANAGEMENT UNIT (MMU) is designed to accommodate the UNIX operating system. It consists of a segment map, which converts the 68010 logical address into a virtual address; and a page map, which partitions the physical memory space into 4 kilobyte pages.

- LOCAL MEMORY consists of 16 kilobytes of EPROM and 4 kilobytes of RAM. EPROM is supplied with a standalone monitor/debugger, bootstrap code, and boot diagnostics which test the various functional blocks on the board. RAM is used in standalone operation (e.g., by the monitor/debugger and diagnostic programs).

- The S-BUS addresses special dual-ported memory cards which incorporate arrays of 64K dynamic RAM chips. Because the S-Bus affords direct access to the memory, the timing constraints of the Q-Bus are eliminated. The interface between the S-Bus data bus BSD<0-15> and the processor data bus is a buffer enabled by the signal AID-. The physical address BA<1-8> RA<9-16> generates the S-Bus multiplexed address. The bank select signals BSB<0-4> are generated from RA<17-21>. All memory accesses are begun on both the S-Bus and the Q-Bus simultaneously; if memory is on the S-Bus, the Q-Bus cycle is aborted. The S-Bus decoder circuitry generates the signal QS+, which identifies the cycle as a Q-Bus cycle. It also generates the S-Bus select signal SSE-, the S-Bus sync signal SSYNC+, and the address multiplexing signals ROW- and COL-. The S-Bus memory present signals are compared with the upper three bits of the physical address RA<19-21> by a type F151 selector. The signal QS+ is asserted if the S-Bus memory corresponding to the physical address is not present; otherwise, a type F74 flip-flop will generate SSYNC+ and SSE- at the next processor clock edge. Q-Bus request and bus error signals from the bus arbitration logic and the disable S-Bus signal from the processor control register hold this flip-flop clear to disable S-Bus operation. The row and column address multiplexing signals are generated by a type F109 flip-flop clocked by the processor

clock. All other S-Bus control signals are generated by buffering the appropriate 68010 processor control signals.

- The REAL-TIME CLOCK CALENDAR is generated by a 32.768 kHz crystal oscillator. A battery is also included for low-power standby operation. The clock gives the date and time in the form of readable registers. The registers can be loaded and counting started with a "GO" command which may be used to synchronize several machines.

- The Q-BUS INTERFACE CIRCUITRY consists of a bus transceiver, bus control signal generation logic, DMA request/grant logic, and a DMA extension register. This circuitry translates the 68010 bus control signals into the bus control signals defined in the Q-Bus specification. It also performs data/address multiplexing and demultiplexing. The DMA logic and extension register is used when alternate devices, such as peripheral controllers, request control of the Q-Bus for DMA transfers.

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Memory Board

The standard memory board on the PowerFrame is a dynamic NMOS random access memory card designed for the LSI-11/23+ microcomputer system. It is available in 256K, 512K or 1024K of storage per quad card, and is easily upgradable. The following features are standard on the memory card:

- DIRECT MEMORY ACCESSING(DMA). Data and address information share the same lines, allowing the use of a single transfer consisting of both an address transfer phase and a data transfer phase. DMA improves system throughput by allowing transfer of information directly between main memory and peripheral I/O devices without direct involvement of the CPU.
- The on-board CONTROL AND STATUS REGISTER (CSR) allows diagnostics to pinpoint a bit parity error to the exact board and chip. Since the chips are socket mounted, field maintenance time is minimal.
- An ON-BOARD PARITY ERROR LED aids in initial system fault determination.
- The 256KB, 512KB and 1MB, 2MB, and 4MB memories are available on a SINGLE CARD. This compact packaging eliminates unnecessary bulk and keeps backplane slots open for other controllers.
- ON-BOARD PARITY GENERATION AND CHECKING are provided, as well as a control and status register to indicate the occurrence and location of parity errors.
- The STARTING ADDRESS of the memory boards can be assigned anywhere within the 128K word address space in 4K word increments or within the extended LSI-11 (Q-Bus) 4MB address space for extended addresses.
- SOCKETED RAM's are standard.
- EXTRA RAM is provided for maintenance.
- The systems can be EASILY UPGRADED from 1/4MB up to 4MB.

Disk Controller

The CQ-06 controller interfaces one or two drives having the same or different transfer rates, number of heads, data surfaces, capacities and other characteristics. The CQ-06 is effective for SMD type drives to be used in a mix-or-match arrangement without changing the controller or components on the controller. Features include:

- 22-BIT ADDRESSING is incorporated in the CQ-06 allowing direct addressing of up to 4 Megabytes of computer memory.
- This low cost microprocessor-based intelligent controller is COMPLETELY CONTAINED on one quad printed circuit module.
- The CQ-06 offers UNIVERSAL FORMATTING. With Universal Formatting, the parameters are recorded directly into the header of each sector of the drive by the operator, instead of being programmed in the components on the controller at the time of manufacture. Two kinds of mapping schemes may be used: vertical and horizontal. VERTICAL MAPPING means that once a track is selected, read or write operations are accomplished by sequentially selecting all heads before moving to another track. In HORIZONTAL MAPPING, a head is selected and read or write operations are accomplished by sequentially selecting all tracks before moving to another head.

Universal Formatting provides complete software emulation when two or more drives, of the same or differing parameters, are attached to the controller. In matching logical unit size with the physical drive size, each drive connected to the controller may use the same or different logical unit sizes. Drive emulations may be mixed on the drive(s) connected to the controller.

- Incorporated in the CQ-06 are three MEDIA FLAW COMPENSATION features used to compensate for data errors whether they are caused by media flaws, minor drive misalignment or weak components in the drive (i.e. soft servo system). First, the CQ-06 flags bad sectors on the disk and assigns alternate tracks when formatting. Second, an automatic read-retry, which will compensate for soft errors due to marginal drive components, is incorporated once the pack is formatted. Third, a 56-bit Error Correction Code (ECC) polynomial is used for detecting and correcting data errors up to 11 bits in length. With this polynomial, the chances of misdetecting and/or miscorrecting

single or double burst errors are greatly reduced when compared with the commonly used 32-bit polynomial.

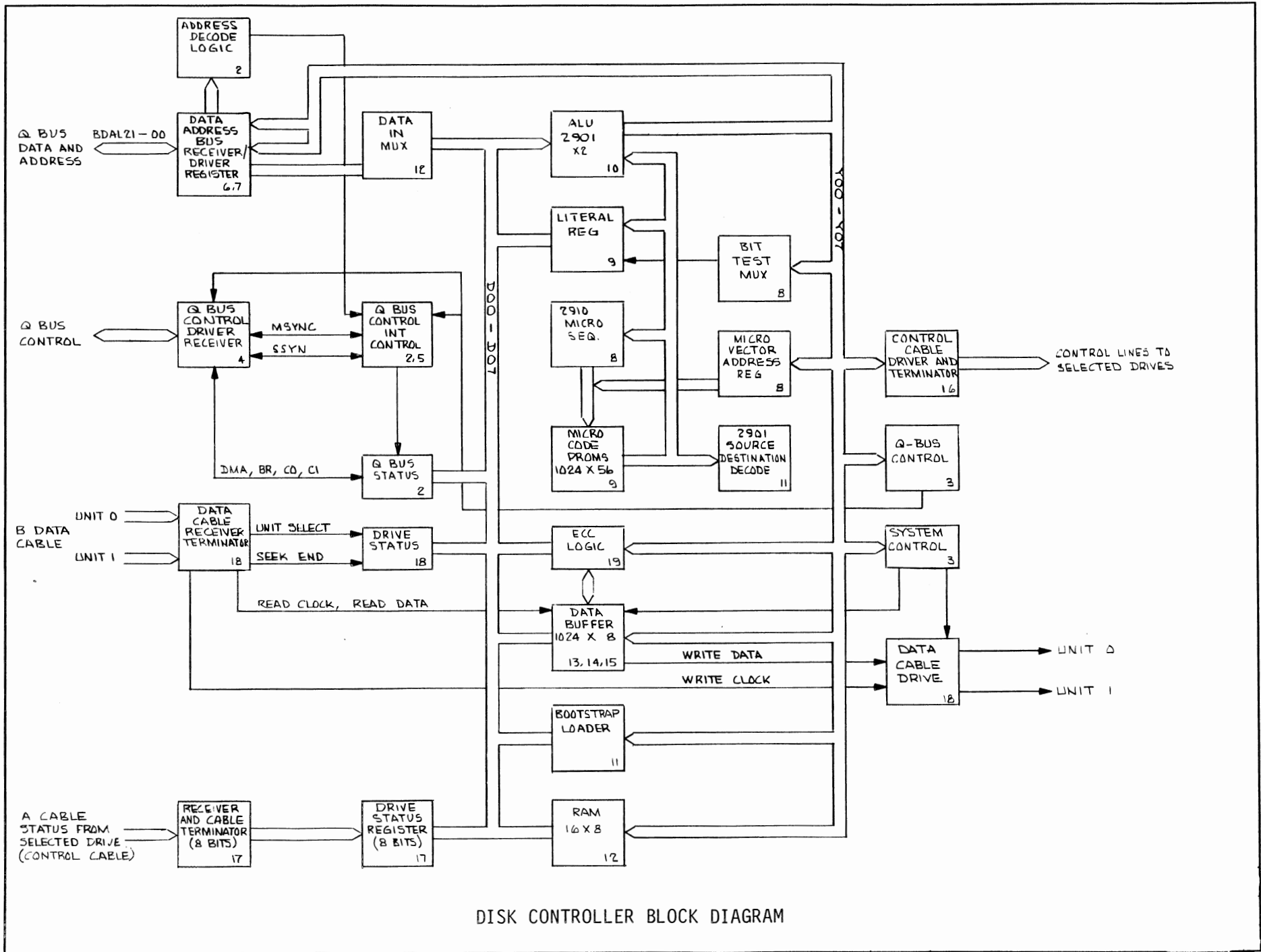
- The CQ-06 includes an ON-BOARD BOOTSTRAP LOADER for RPO2/RPO3, RK06/RK07, RX02, RK05, RL01/RL02, TS-11, and TM-11 magnetic tape support. On-board jumpers allow selectable bootstrap addresses, in addition to enabling/disabling the bootstrap. When the bootstrap is disabled, the CQ-06 will boot from the standard module.

- The CQ-06 supports various DEC OPERATING SYSTEM SOFTWARE, including RT-11, RSX-11, RSTS, and ULTRIX, and is transparent to the user.

- A high speed, proprietary BIPOLAR MICROPROCESSOR CONFIGURATION is at the heart of the CQ-06. The majority of controller functions are implemented in firmware. This allows a significantly reduced parts count.

- The CQ-06 contains an AUTOMATIC SELF TEST feature which causes on-board micro-diagnostics to be run on the controller each time the Q-Bus is initialized. A green card-edge LED indicator is lit and remains lit after each successful completion of the micro-diagnostics. Should the micro-diagnostics fail, the LED indicator is extinguished and a data protect feature is invoked, disallowing any communications between the CPU and the disk. This protects critical data base areas from being overwritten.

- The CQ-06 with its LOW POWER SCHOTTKY CIRCUITRY and SINGLE BOARD ARCHITECTURE, uses up to 60% less power than other similar SMD type disk controllers.



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Multiplexed I/O Board

The PowerFrame employs 8-channel, multiplexed, asynchronous serial line interfaces. These dual-wide boards each occupy one half quad slot in the PowerFrame card cage. The multiplexer was designed especially to interface to the Q bus. It consists of three basic units: Q bus interface, control logic, and line interface. Each dual-wide board provides eight ports for local or remote communication. The multiplexer is software compatible with the DEC DZ11 driver. The dual-wide module plugs into any Q-Bus slot.

Serial Line Interface Board

The PowerFrame models 7340 and 6840 do not carry a serial line interface onboard the CPU board. These models employ a multifunction board for the two system I/O ports. At present, the asynchronous serial lines are the only functions used on this board. These lines are standard RS-232. The baud rate for each unit is DIP switch selectable.

Backplane

The BQ-84 is an 8-slot quad backplane which swings out to allow easy access to the boards from the front of the unit. Features of the BQ-84 include:

- The BQ-84 conforms to the INDUSTRY STANDARD Q-BUS, allowing other Q-Bus compatible devices to be attached to the backplane.

- Space on the the backpanel allows connectors to tie to additional card cages if the EXPANSION PORT is used. Space is also provided for bus terminating resistors when needed.

- Six jumper pins offer the option of setting up the card cage as either the first or the last in a system.

- The BQ-84 busses BDAL18 (BC1), BDAL19 (BD1), BDAL20 (BE1), and BDAL21 (BF1) to all card positions, supporting 22-bit addressing. These additional four lines for DMA transfers distinguish the Q-Bus from the LSI-11 bus.

- The BQ-84 implements a four-level interrupt scheme on a "serpentine" board layout. Position-independent configuration allows peripheral devices using the 4-level interrupt scheme to be placed in the backplane in any order. Logical priority is assessed on the basis of assigned priority levels 4 through 7. If more than one device of the same logical priority requests an interrupt simultaneously, the processor will arbitrate the priority decision on the basis of electrical proximity to the CPU. Because of the serpentine layout, device boards must be installed in a sequential manner, following the serpentine characteristics of the bus.

DC-40 Disk Drive

The 2340 PowerFrame is equipped with a 40MB disk drive. An expansion unit can be added to the main unit which will accommodate a second drive. This drive can be the standard 40MB drive or an 80MB drive.

40MB Drive

The DC-40 offers a combination of speed, capacity, reliability, and packaging efficiency for high-performance mini or microcomputer based systems. Features of the DC-40 include:

- The DC-40 provides 40MB FORMATTED STORAGE, including 20 Mbytes of fixed storage, and 20MB of removable storage on an ANSI Standard disk cartridge.

- The DC-40 is compatible with SMD INTERFACE.

- The DC-40 features ADVANCED WHITNEY HEAD SUSPENSION and READ/WRITE TECHNOLOGIES derived from the latest generation of mainframe disk drives, including:

IMPROVED AERODYNAMIC SUSPENSION - Due to the low-mass geometry of the suspension assembly to which the recording transducer is attached, the DC-40 offers greater stiffness of the air bearing and suspension. The result is fewer errors in head-to-disk spacing and track following.

LOW-MASS SLIDER - This, combined with the smaller physical size of the suspension and air bearing, resists bounce, pitch and roll, resulting in significantly fewer interfering frequencies.

ENCODING TECHNIQUES - Use of the Whitney "Run Length Limited Code" (RLLC) provides advantages over the Winchester such as a 50 percent increase in bits-per-inch with respect to flux changes-per-inch, limited band-width to run-length limitations, self-clocking, and optimization for use on present head and disk technologies.

- DC-40 incorporates a MICROPROCESSOR CONTROLLED EMBEDDED SERVO SYSTEM, which eliminates head/disk alignment problems.

The microprocessor directs all head movement operations and computes the runout profile for each cartridge, resulting in fast, accurate seeks and absolute tracking accuracy for cartridge interchangeability.

- The DC-40 HEAD-LOADING MECHANISM and POSITIVE-PRESSURE CLEAN-AIR SYSTEM further improves performance and reliability. When the cartridge is loaded, the heads are held off the disk until the cartridge is purged to a fixed-media cleanliness. This allows the DC-40 Drive to be used in a wide variety of office, laboratory, or industrial environments.

- The DC-40 Drive provides MICROPROCESSOR-CONTROLLED DIAGNOSTIC ROUTINES, which are automatically executed at start-up.

DF-72 Drive

The DF-72 Drive contains a non-removable 8-inch hard disk drive in a sealed module. Head positioning is performed by a rotary actuator using a closed loop servo. The maximum formatted storage capacity of the DF-72 is 80 MB. Some of the DF-72 features include:

- Industry standard SMD INTERFACE allows additional drives to be added to the existing disk configuration.
- Fixed SECTOR LENGTH FORMATS are internally selectable.
- The built-in DC SPINDLE MOTOR, completely SEALED DISK ENCLOSURE, and highly RELIABLE PRINTED CIRCUIT ASSEMBLIES reduce the necessity for maintenance.
- LOW ACCOUSTICAL NOISE LEVEL and nominal vibration make the DF-72 very suitable for the office environment.
- The standard MEDIA DEFECT FORMAT is divided into two parts: a hard-sectored format and a soft-sectored format.
- The COMPLETELY SEALED DISK ENCLOSURE contains the disks, spindle, actuator, and heads. Each of these are visible through the plastic cover.
- Clean air is supplied to the sealed disk enclosure through TWO FILTERS. The breather filter, used for external air intake, prevents negative pressure in the vicinity of the spindle when the disk begins to rotate. It also prevents dust intake when the air in the disk enclosure contracts due to a temperature difference between the disk enclosure and its environment. The re-circulation filter, attached to the closed loop duct in the disk enclosure, keeps the air free of foreign particles, preventing head crashes. When a pressure difference occurs in the disk enclosure due to the rotation of the spindle, air is recirculated through the closed loop. These two filters remove 99.97 percent of dust particles in the disk enclosure.
- A HALL-EFFECT SENSOR detects movement of a device mounted on the hub, and produces a signal. This signal is compared with an oscillator clock on the PCB in order to maintain the 3,600 RPM rate of the disk.
- A low power consumption ROTARY TYPE ACTUATOR moves the data

heads and servo head to the specified cylinder along a circular arc. The actuator performs two types of motion, both of which are controlled by servo feed-back current from the servo head. In Seek motion, the heads are moved to the specified cylinder, counting track crossing signals. In "On Cylinder" motion, the heads follow the specified tracks in a way designed to prevent mispositioning from disturbances such as shock, vibration, or temperature fluctuation.

- The DF-72 contains FOUR PLATTERS. These platters are 200 mm (8 inches) in diameter, and are aluminum substrate-coated. They are also coated with a lubricated iron oxide. Reference servo patterns are factory pre-written on the bottom side of the lowest disk. The platter surface can sustain 10,000 start/stops without damage.

- A single SERVO HEAD is mounted on the lower head arm to read the factory pre-written servo pattern. This information controls the read/write operations and is used to provide a seek control index and a selectable count of sector pulses.

- SEVEN HEADS are used in the DF-72. The heads are in contact with the media surface when the platters are not rotating, and they lift off with rotation. A landing zone out of the data area is provided when the heads contact the media.

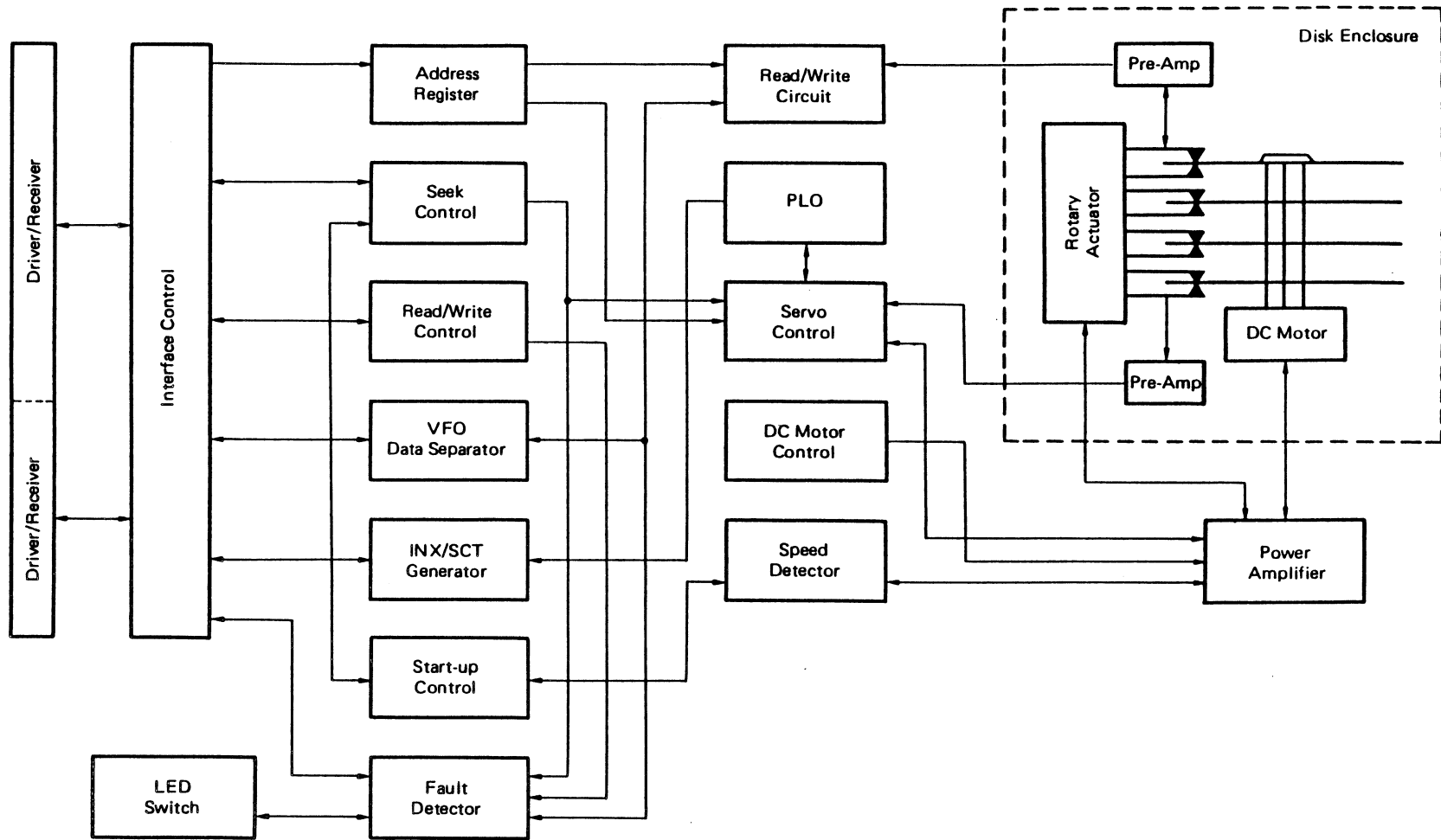
- Three PRINTED CIRCUIT BOARDS (PCBs) are mounted on both the topside and the bottomside of the disk drive. The PCBs perform the following functions:

- SMD INTERFACE is enabled/disabled by the controller.

- DRIVE STATUS, such as On Cylinder, Fault, Seek Complete, Write Protect, Index, and Ready, are made available to the interface.

- SERVO CONTROL CIRCUITS take the Cylinder Address command from the interface and control the seek operation to any desired cylinder.

- SPINDLE SPEED CONTROL CIRCUITS monitor the speed of the spindle/drive motor and maintain 3,600 RPM +/- one percent.



DISK DRIVE BLOCK DIAGRAM

Software

Typically, the complete PowerFrame software is shipped to the customer on the 20MB removable disk cartridge. The software consists of the operating system, the customer's software, and optionally the PowerGen applications generator.

For a nominal fee, a copy of the the customer's software (programming languages, compilers, etc.) is sent to the PowerFrame factory on either a magnetic tape, RL02 cartridge, or RX01/02 floppy disk. The software is then written onto the disk containing the operating system and sent back to the customer.

An operating system consists of a series of programs and routines which organize the system's hardware devices into an efficient working unit, enabling data to be processed. In addition, operating systems usually include a set of system utilities and routines designed to perform various tasks such as managing I/O devices, maintaining user accounts, protecting information, and detecting program errors.

Operating systems differ according to the hardware with which they are compatible, the programming languages they support, the complexity of tasks they can handle, and the purposes for which they are to be used. PDP11 operating systems consist of two sets of software: MONITOR (or EXECUTIVE) SOFTWARE and SYSTEM UTILITIES.

MONITORS are the primary interface between the hardware, the program running on the system, and the computer operator. Most monitors are composed of two distinct portions, one resident in the memory and one temporarily resident, or transient. The memory-resident portion remains in the memory in order to act on requests from processing programs, such as blocking and unblocking data, allocating storage space, managing files, and scheduling. The transient part of the monitor is responsible for loading and starting programs, controlling program execution, modifying or retrieving system information, and setting system parameters.

SYSTEM UTILITIES are programs supplied by the manufacturer to perform system-level operations under the control of the monitor. There are three basic types of system utilities. PROGRAM DEVELOPMENT utilities include text editors, assemblers, compilers, linkers, program librarians, and debuggers. FILE MANAGEMENT utilities include file copy, transfer and deletion programs, file format translators, media verification and clean up programs. SYSTEM MANAGEMENT utilities include system information programs, user accounting programs, error logging, and on-line diagnostic programs.

RSX-11M and RSX-11M-PLUS Operating Systems

The RSX-11M-PLUS is a MULTIPROGRAMMING operating system based on a priority-ordered queue of programs demanding system resources. The memory of the RSX-11M-PLUS is divided into several partitions into which individual tasks are loaded. While only one program can have control of the CPU at one time, other system resources, particularly I/O device operations, can execute in parallel, allowing the concurrent execution of several tasks.

The RSX-11M operating system has a subset of the capabilities of RSX-11M-PLUS and is designed to run on small- and medium-sized LSI-11 systems. Its multiprogramming capabilities permit RSX realtime activities to execute concurrently with less time-critical activities such as program development, text editing and data management.

The RSX-11M/11M-PLUS operating systems, designed to run on LSI-11/23+ and LSI-11/73 computers, take advantage of the expanded memory capability of these machines to provide excellent performance and flexibility. RSX-11M-PLUS unique features include:

- The RSX-11M-PLUS supports USER MODE I/D SPACE hardware, which gives the user the ability to address up to 32K words of instruction and 32K words of data at the same time. This reduces the need for overlays, simplifying the development and enhancing the performance of large application programs.
- MULTISTREAM BATCH processing capability allows the operations personnel to control the number of batch streams that can run. When the number of batch jobs submitted exceeds the number of batch streams available, the remainder of the batch jobs are held in a batch input queue. The operator controls the batch job queue by changing priority, holding, or killing jobs.
- I/O REQUEST QUEUE OPTIMIZATION allows request queues for disks to be sorted by the cylinder number of the request, resulting in reduced seek length and up to a 30% throughput improvement.
- PERFORMANCE ENHANCEMENTS, such as overlapped disk seeks on RSX-11M-PLUS allow more disk accesses per unit of time. Communications microprocessors reduce the system load of interprocessor communications. Priority scheduling and other controls further enhance performance.

- RSX-11M-PLUS provides its own ACCOUNTING SYSTEM to maintain records of system resource use, and stores these records in an accounting log file. Reports on the use of system resources and bills for use can be generated either by user name or account name.

Features common to RSX-11M-PLUS and RSX-11M include the following:

- The RSX-11M systems use DIGITAL COMMAND LANGUAGE (DCL) to establish and control the processing environment. DCL provides an extensive set of commands for interactive program development, device and data file manipulation, and interactive and batch program execution/control.

- Hardware MEMORY MANAGEMENT provides automatic memory protection. Each task is assigned a specific address range in which to execute, protecting it from other tasks operating in the system. Software priority levels allow optimization of CPU use, as well as flexible performance options. The RSX-11M systems provide 250 priority levels to allow efficient concurrent processing of time-critical tasks, interactive terminals, and background computation.

When a "significant event" (such as an I/O completion) occurs, the system automatically interrupts the executing task and searches for the highest priority task that is ready to execute. Processor time is distributed evenly and rotates so that each task has its own turn at the top of the queue.

When a higher priority task requests a partition, a lower priority job may be interrupted and swapped out of memory to disk. This is called "checkpointing." Later, after the higher priority task has finished processing, the checkpointed task will resume execution where it left off.

The RSX-11M systems are also able to dynamically allocate available memory in system-controlled partitions, allowing a task to be loaded anywhere there is room for it, maximizing memory use.

- CLUSTER LIBRARY SUPPORT eliminates the need to simultaneously map all libraries to the task address. Using cluster libraries, only the library in use is actually mapped to the task address space, leaving more task address space for application code.

- The ERROR LOGGER provides complete and easy to read reports,

including error logging and reporting of customer added devices.

- The TASKBUILDER creates loadable memory images from assembled or compiled tasks. It links relocatable object modules and resolves any reference to global symbols, common areas, and shared libraries. The taskbuilder specifies a task's attributes and creates shareable commons. It can link an unlimited number of library files and up to seven virtual memory areas. The taskbuilder also provides an overlay descriptor language to construct task overlays.

- The LIBRARIAN (LBR) allows the user to create and maintain disk-resident libraries of object modules and user-defined macros. "Universal libraries" (libraries whose entries may be any files legal under FILES-11, including ASCII files, object files, executable task images, etc.) may also be created and maintained through the librarian.

- Optional with the RSX-11M systems is the FORMS MANAGEMENT SYSTEM (FMS). The FMS allows programmers to create applications that use forms displayed on the terminal screen to handle user inquiry or response.

- The OCTAL DEBUGGING TOOL (ODT) aids in debugging programs that have been assembled or compiled and taskbuilt. From the keyboard, ODT can be used to print or change the contents of a location in the task, run the program using breakpoint features (which halt the program at specified points), search the program for a specific bit pattern, or calculate offsets for relative addresses.

- FILES-11 oversees the storage and handling of user and system files on volumes. Each volume contains its own set of file directories and information on the protection, size and location of the files on the volumes. The FILES-11 files may be manipulated with system utilities or user-written tasks.

- RECORD MANAGEMENT SERVICES (RMS) enable a programmer to choose the record access method best suited for the data processing application. The record access methods are independent of the language in which they are programmed. RMS allows relative, sequential, and multikey indexed sequential file organizations, and permits access mode to be sequential, random, or according to Record File Address.

- EDT, the standard DEC editor is supported under the RSX operating systems.

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RSTS/E OPERATING SYSTEM

RSTS/E is a multiprogramming operating system which processes jobs on a "timesharing" basis. TIMESHARING is a method of allocating the CPU into a prioritized, scheduled environment, capable of running several jobs concurrently. A job runs until it either reaches an I/O wait state, or its allotted time runs out. When this occurs, the scheduler begins running the next ready job. If more memory is required to run a job than is available, the system temporarily "swaps" some jobs out of memory and stores them in a swap file, until they are able to be run again. Timesharing provides optimal, efficient use of a system's resources. The RSTS/E operating system offers these features:

- The most popular PROGRAMMING LANGUAGES for business and educational applications are available with the RSTS/E system, including BASIC-PLUS-2, MACRO-11, COBOL, COBOL-81, FORTRAN IV, FORTRAN-77, and DIBOL.
- RSTS/E can accommodate up to 127 users and 63 jobs at one time.
- EDT, the DIGITAL STANDARD TEXT EDITOR, can be used to create a file, enter and manipulate the file text, and save or delete work done during edit sessions. EDT provides full screen video editing.
- RECORD MANAGEMENT SERVICES (RMS) supports the building and accessing of sequential, relative, and multikey indexed sequential file structures, and many tedious tasks of I/O management.
- The optional FORMS MANAGEMENT SYSTEM (FMS) provides sophisticated screen formatting, eliminating the need to edit and recompile a forms program. FMS offers extensive field protection and validation features that prevent data typing errors.
- The RSTS/E FILE SYSTEM offers a wide range of on-line processing capabilities. Files may contain alphanumeric string, integer numeric, floating point numeric, or binary data. They can be created, updated, extended or deleted interactively from either the user's terminal or under program control, and can be sorted by the SORT-11 program. Files can be accessed randomly or sequentially, through either a keyboard command or utility program, or through the RSTS/E file system. Protection on an individual, group, or system basis is available.

- Total or selective FILE BACKUP AND RESTORE can be done on-line without disrupting users, or during periods when timesharing or application processing is not permitted.
- The USER COMMAND LANGUAGE enables users to log into the system, manipulate files, develop and test programs, and obtain system information. The four standard keyboard monitors are DCL, BASIC-PLUS, RSX, and RT-11. All of these interpret sets of system commands, allowing the user to perform all of the fundamental functions required to use the RSTS/E system.
- RSTS/E is compatible with DIGITAL COMMAND LANGUAGE (DCL). DCL may be implemented as a run-time system or as an additional keyboard monitor.
- The RSTS/E SYSTEM CODE is tailored at system generation time according to the hardware configuration and software features of the system. The system code is stored on the system disk as a save-image library (SIL), and when loaded into memory, is immediately executable by the LSI-11 computer. Elements of the system code include the following: interrupt and trap vectors, system information and data tables, small and large system buffers, disk and device drivers, file processor modules, FMS/RSTS forms code in the terminal driver, DECnet/E Network Communications handler, and RJ2780 Remote Job Entry handler. Other elements, which may be either permanently resident or disk resident (overlay), include file processor modules and infrequently used utility routines. System initialization code is loaded only at system start-up. RSTS/E operations begin when the system disk is bootstrapped. This loads the initialization code which determines the hardware configuration and performs many consistency checks to ensure the integrity of the software.
- The system can be defined to have one or more PSEUDO KEYBOARDS. A pseudo keyboard may be used to write a program to control other jobs. Each copy of the BATCH system program requires one pseudo keyboard to run jobs in a batch stream.
- The MULTIPLE TERMINAL SERVICE option allows one program to interact with several users simultaneously by servicing their terminals on one I/O channel.
- FLOATING POINT NUMERIC FORMAT may be selected as a system option with either single precision (2-word) or double precision (4-word) format. SCALED ARITHMETIC may also be used if the system has floating point hardware. Scaled arithmetic avoids loss of precision in floating point calculations.

- Up to 50 SYSTEM-WIDE LOGICAL NAMES may be assigned by the system manager.
- The optional FILE PROCESSOR BUFFERING module accelerates file processing on the RSTS/E system by maintaining more than one disk directory block in memory. This reduces the number of accesses to disk.
- RSTS/E supports software DATA CACHING of file directories and file data blocks. Software disk cache is a dynamically allocated portion of main memory in which blocks of disk-accessed file data are stored. When a request is made to read a disk block, the operating system first checks the cache. If the block of data is there, a physical disk access is avoided, resulting in faster program execution. Specific files can be designated for caching, or all files may be cached. Cache size is determined by the system manager.
- RSTS/E includes SYSTEM MANAGEMENT UTILITY PROGRAMS for both the system manager (privileged use only) and for the general user (non-privileged use). System management utilities include: system initialization and maintenance programs, resource management and accounting programs, system error logging and analysis programs, operator services and spooling programs, and user communication programs.
- RSTS/E systems have three SYSTEM ACCOUNTS AND LIBRARIES that are integral to the operation of the system. The MASTER FILE DIRECTORY (MFD) account is used to control system access. The SYSTEM LIBRARY account manages a library of system programs, message and control files. A third special system account contains RSTS/E monitor files and routines.
- The RSTS/E system offers PRIVILEGED CAPABILITIES options. A job with a privileged condition has capabilities not available to other, non-privileged jobs, such as: unlimited access on the system, ability to designate privileged programs, use of privileged aspects of system programs, use of privileged SYS system functions and the PEEK function.
- RSTS/E provides several GENERAL SYSTEM UTILITY PROGRAMS available to the general user. These programs include: system information and terminal utility programs, file utility programs, and special service programs.
- BATCH PROCESSING allows the user to submit jobs to be run without terminal dialogue. BATCH is particularly useful in executing large data processing operations for which interactive

requirements are not a factor. It is possible to execute multiple batch streams simultaneously by running multiple copies of the BATCH program.

- The LOGICAL DISK STRUCTURE is divided into two types, public and private. Any user can create files on a public disk, but a private disk belongs to fewer user accounts (conceivably a single user account), and files may be created or accessed only if the protection code of the file permits. The physical file structure on a disk, whether public or private, is the same.

- There are several FILE ACCESS METHODS available on the RSTS/E system. RMS-11 is the main file and record access method. It is used by BASIC-PLUS-2, MACRO-11, COBOL, COBOL-81, FORTRAN-77, MACRO-11, and DIBOL-11. RMS-11 supports sequential, relative, and indexed file organization. RMS-11 can accommodate fixed length records, variable length records, variable length records with fixed control fields, and stream records.

BASIC-PLUS on RSTS/E provides three methods of file access: Formatted ACSII (for standard sequential I/O operations), Virtual Arrays (for random access of large data files), and Record I/O (for complete control over I/O operations).

DMS-500 is the third type of file access available on the RSTS/E system. The major components of DMS-500 include ISAM/RAM (Indexed Sequential/Relative Access Method), IAM (Indexed Access Method), and DSORT (Extended Disk Sort).

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RT-11 Operating System

The RT-11 operating system was designed as a compact system for realtime single-user applications. It offers sophisticated, reliable technology in a small, low-cost system. Features of the RT-11 operating system include the following:

- The RT-11 system offers one of three types of MONITORS. The SINGLE-JOB (SJ) monitor organizes the system for single-user, single program conditions. The FOREGROUND/BACKGROUND (FB) monitor provides efficient use of waiting time by allowing the CPU to be used for another job (background) while the principle job is pausing. The EXTENDED MEMORY (XM) monitor allows both foreground and background jobs to extend their logical program space beyond the 64K byte space imposed by 16-bit addresses on PDP-11 computers. The XM monitor is capable of addressing up to 248 Kbytes of memory.
- The RT-11 Operating System offers a wide range of SYSTEM UTILITIES and SOFTWARE COMPONENTS. These include:
 - The RT-11 operating system uses DIGITAL COMMAND LANGUAGE (DCL).
 - The PERIPHERAL INTERCHANGE PROGRAM (PIP) is used to transfer files between any of the RT-11 devices and to merge, rename, and delete files. PIP protects files against accidental deletion.
 - The DEVICE UTILITY PROGRAM (DUP) is a device maintenance program, capable of creating and extending files, as well as compressing, scanning for bad blocks, image copying, initializing, and booting on RT-11 file-structured devices.
 - The DIRECTORY PROGRAM (DIR) performs a wide range of directory listing operations, such as: listing directory information about a specific device, providing details about certain files, and printing a device directory summary. The directory can organize its listings alphabetically and chronologically.
 - The COMMAND STRING INTERPRETER (CSI) accepts a line of ASCII input (usually from the console operator) and interprets it as a string of input specifications and options for system utility programs.

- The LIBRARIAN (LIBR) allows for the creation, update, modification, and maintenance of library files. A library file is a direct access file that contains one or more modules of the same module type.
- DUMP (DUMP) is the RT-11 program that prints on a console or line printer, or writes to a file, all or any part of a file in octal words, octal bytes, ASCII characters, or Radix-50 characters.
- The FILE EXCHANGE PROGRAM (FILEX) is a general file transfer program that converts files into different formats to be used with other operating systems.
- The SOURCE COMPARE PROGRAM (SRCCOM) compares two ASCII files and lists the differences between them. SRCCOM is particularly useful when it is necessary to compare two versions of the same source code.
- The BINARY COMPARE PROGRAM (BINCOM) compares two binary files and lists the differences between them.
- The RESOURCE PROGRAM (RESORC) displays information about the system configuration.
- The RT-11 LINKER (LINK) converts object modules produced by an RT-11 supported language processor into a format suitable for loading and execution. The linker is able to relocate each object module, assign an absolute address, and link the modules by matching global symbols defined in one module and referenced in another. The linker will search libraries specified by the user to locate any unresolved globals. It will also produce a map indicating the layout of the executable module, and a symbol definition file.
- The RT-11 ON-LINE DEBUGGING TECHNIQUE (ODT) aids in debugging assembly language programs. With ODT, the execution of programs can be directed from the terminal.
- The PATCH (PATCH) utility program is used to make modifications to any RT-11 file. PATCH can be used to examine and change bytes or words in the file.
- The SAVE IMAGE PATCH PROGRAM (SIPP) allows modifications to be made on any RT-11 file that exists on a random-access storage volume. SIPP can be used from the console, an indirect command file, or a BATCH stream to patch all files created with the linker. SIPP was designed to replace the earlier PATCH

utility; however, PATCH is included in Version 4 to accommodate those who have published patches prior to this release.

- The OBJECT MODULE PATCH (PAT) utility allows any code in a relocatable binary object module to be patched or updated. PAT does not allow examination of the octal contents of an object module; that is a function of SIPP. With PAT, relatively large patches can be added to an object module without having to perform any octal calculations.

- The SOURCE LANGUAGE PATCH (SLP) program is a patching tool that can be used to modify source files. When used with SRCCOM, SLP will patch a source file so that it will match an edited version.

- EDIT (EDIT) is one of the text editors offered by the RT-11 system. EDIT creates or modifies ASCII source files and prepares them as input to other programs, such as compilers or assemblers. EDIT is a line-oriented editor, most useful for hard copy terminals. The function of EDIT is to locate the text to be changed, execute and verify the changes requested, list a copy of the edited page on a terminal, and output the page to the output file.

- KED (KED) is the other text editing program that RT-11 employs. KED is a video display editor designed for use with VT100 and VT100-compatible terminals. It takes advantage of the terminal's special keypad, which provides quick operation of various editing functions. KED provides a HELP file to make keypad editing easy.

- RT-11 BATCH is a complete job control language that allows RT-11 to run jobs that require little or no user interaction. An RT-11 BATCH stream may be executed from any legal RT-11 input device, and a log file may be output to any legal RT-11 output device (except magtape or cassette). The BATCH stream may be executed from any of the three monitors, and RT-11 monitor commands may be given from the BATCH stream.

- The SYSTEM JOBS FEATURE permits an FB or XM monitor created through system generation to run up to six extra jobs, in addition to the normal foreground and background jobs.

- QUEUE, the file queueing package, allows files to be sent to any valid RT-11 device. QUEUE is particularly useful for obtaining hardcopy listings of files, but it is not restricted to a line printer or to other serial devices. QUEUE is run

either with the FB or XM monitors, as either a foreground or a system job. QUEMAN, the user interface to QUEUE, runs in the background.

- The ERROR LOGGER (EL) keeps a statistical record of I/O activities to monitor the hardware reliability of the system. The error logger produces individual or summary reports at specified intervals of time on some or all of the errors that have occurred.

- The SYSTEM SUBROUTINE LIBRARY (SYSLIB) is a collection of FORTRAN-callable routines that allows a FORTRAN user to access various features of RT-11 foreground/background (FB) and single-job (SJ) monitors. SYSLIB also provides various utility functions, a complete character string manipulation package, and two-word integer support. This is the default library that the linker uses to resolve undefined globals. It is resident on the system device. SYSLIB allows a FORTRAN IV user to write almost all application programs completely in FORTRAN IV with no assembly language coding.

- AUTOPATCH eliminates the need to manually install patches published in the RT-11 Software Dispatch by automatically installing mandatory patches to modules on unaltered distribution kits of RT-11 and some of its products. Machine-readable patches, which eliminate the need for typing, are also available, but AUTOPATCH does not automatically install these patches.

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UNIX Operating System

Unix is a flexible, multi-tasking, multi-user operating system which offers several levels of user access and file protection, inter-processor and inter-user communication, and an extremely flexible I/O subsystem. Features standard on the UNIX operating system include:

- The Unix operating system consists of a layer of processes around a central "KERNEL." The kernel supports the I/O subsystem, allows for the creation of new processes, controls scheduling, provides memory management, and supports a wide range of system commands.
- The primary interface to the Unix system is called "THE SHELL." The shell is the command interpreter, providing easy-to-use, concise communication to all the capabilities of the kernel. The shell enables the user to set up I/O redirection with a few simple commands instead of a page full of information, as is common on most systems.
- The Unix system features I/O REDIRECTION, in which every stream of characters is treated as an unformatted stream. This allows application processes to format characters in an arbitrary manner, according to the device or file it is sent to, thus eliminating time-consuming translation.
- Unix provides FILE PROTECTION to limit access to selected files and directories.
- An extensive selection of SYSTEM COMMANDS gives Unix remarkable flexibility. Commands are available to manipulate the file system, operate system timers, allocate/deallocate resources, transmit messages between processes, and so on.
- The Unix system utilizes SIGNALS to aid in the management of asynchronous events. Signals are the software equivalent to hardware interrupts. If a software program is interrupted, the current registers and status of the process are saved, allowing the process to resume where it left off.
- "PIPELINING" enables the user to chain together two or more process commands, allowing complex processes to be executed with minimal operator intervention.
- "WRITER'S WORKBENCH," a documentation generator, offers a word

processing program, a typesetting program, a spelling editor, and even a style editor, which monitors the use of verb tense.

- The Unix system offers diverse NETWORKING CAPABILITIES. Unix-to-Unix Copy (UUCP) networks any arbitrary set of Unix machines over phone lines. Support is also available for dedicated private networks. Unix's ETHERNET software supports local area networking, where node distance is minimal and transmission occurs over a co-axial cable.

- A DATABASE FILE SYSTEM may be implemented with Unix. - UNIX features SHARED MEMORY, allowing two or more users to share the same data without having to transfer it. SEMAPHORE LOCKING/UNLOCKING guarantees exclusive use to any selected memory segment, file, or process.

- The Unix operating system can accomodate an UNLIMITED NUMBER OF USERS, depending on the power of the machine used.

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PowerGen Applications Generator

1. Introduction

As an option, the customer can purchase the PowerGen applications generator software package, which runs under RSX and UNIX operating systems. The software will be shipped to the customer on a 20MB disk cartridge for easy installation.

The customer can purchase the complete PowerGen package, which includes the PowerGen run time system plus five applications: Accounts Payable, Accounts Receivable, Payroll, Order Entry/Inventory, and General Ledger. Alternatively, the customer can purchase the run time system and the Accounts Payable application only.

The PowerGen applications generator is a menu driven program in which the user sits at the terminal and answers PowerGen's queries in order to define custom databases. When the databases are defined to the customer's satisfaction, PowerGen allows the user to maintain and query the database. PowerGen also produces a complete set of documentation for the user's customized application. The finished application is totally debugged, documented, and operational.

PowerGen is a "data driven" or "parameter driven" software development package. It is called data driven because a small number of programs are executed during run-time. These programs, or modules, are repeatedly executed, though, and constantly reference a large amount of data stored in special files called parameter files. These files are constantly being built, updated, deleted, and referenced during the application run-time. The following sections highlight the salient features of the PowerGen software and the user interface.

1.1 Software

The PowerGen software can be divided into three different sections, which translates into three phases of execution. These phases are as follows:

Development Phase

Run-time Phase

Documentation phase

The development phase involves the building of the parameter files which are used heavily at run-time. A group of programs called the PowerGen Development Modules, build these parameter files.

The runtime phase consists of the execution of the PowerGen run-time modules repeatedly. These modules build, update, and reference and delete a file called the Applications Data File. In addition, the run-time modules are responsible for the printing of all reports, journals, etc.

In the documentation phase, a group of programs called the PowerGen Documentation modules reference the parameter files to generate the application documentation.

As one may see from this short description, PowerGen is driven mainly by the parameters in the run-time parameter file.

1.2 User Interface

The first menu the user sees after entering PowerGen is the following:

APPLICATIONS SYSTEM GENERATOR

NEW APPLICATION SYSTEM SETUP

1. ENABLE POWERGEN IN A USER ACCOUNT
2. CREATE ALL FILES
3. MAINTAIN SETUP RECORDS
4. PRINT SCREEN WORKSHEETS
5. PRINT REPORT WORKSHEETS

SCREEN FUNCTION CREATION

6. INITIALIZE SCREEN FUNCTION
7. ENTER PROGRAM NAME
8. MAINTAIN MENU ITEMS
9. MAINTAIN SCREEN HEADINGS
10. MAINTAIN SCREEN PROMPTS
11. CREATE RUNTIME FUNCTION
12. CREATE DICTIONARY

REPORT FUNCTION CREATING

13. INITIALIZE REPORT/POSTING MAINTENANCE
14. REPORT/POSTING TITLE MAINTENANCE
15. REPORT SELECTION CRITERIA MAINTENANCE
16. REPORT SORTING MAINTENANCE
17. REPORT HEADING MAINTENANCE
18. REPORT FORMAT MAINTENANCE
19. REPORT TOTALS MAINTENANCE
20. POSTING MAINTENANCE

APPLICATION SYSTEM DOCUMENTATION

21. CREATE OPERATOR DOCUMENTATION
22. CREATE REPORT DOCUMENTATION
23. CREATE FILE MATRIX DOCUMENTATION
24. CREATE FILE LAYOUTS
25. RUNOFF DOCUMENTATION

From this point on, all interaction with PowerGen is through screen prompting. The functions shown above are only the major functions within PowerGen, there are many sub-functions. Screen prompts ask the operator for specific function ranges and other operator-specified parameters.

Physical, Environmental, and Electrical Characteristics

1. Introduction

This section contains the physical specifications for the PowerFrame case and the power supply. It also contains information on the state of the UL and FCC certification for the PowerFrame.

1.1 Case

The compact yet graceful appearance of the PowerFrame makes it at home in the modern office environment. The chassis is enclosed in a rigid plastic case and slides out through the front for easy service. The physical specifications for the assembled PowerFrame case and chassis are as follows:

Weight - 100 lbs.

Height - 23 inches

Depth - 30 inches

Width - 7 inches, 10 inches at bottom with pedestal

The industry standard (RETMA) rack-mount module is supplied without the PowerFrame enclosure and thus differs in dimensions:

Height - 5.25 inches

Width - 19 inches

Depth - 26 inches

The expansion module is formed by detaching the two halves of the plastic case and bolting a leaf at the top and bottom to reconnect the two halves. This process forms a double wide case in which the main and expansion chassis fit. The PowerFrame in this configuration widens to 12.25 inches with a 15.25 inch base.

1.2 Power Supply

The PS-250 open frame switcher is a custom power supply unit designed to accommodate the special needs of the PowerFrame advanced technologies. The following features are available with the PS-250

- The PS-250 switcher provides ADDITIONAL PEAK POWER capability to accommodate initial "turn-on/spin-up" loads experienced by the power drive.
- International input capability (90-132/180-264 VAC 47-440Hz) allows the the PS-250 to be used in any country.
- Built-in line filtering meets the requirements of FCC and VDE 0871 Level A.
- 3750 VAC Safety Isolation (4mm spacing primary to GND, 8mm spacing primary to secondary) is standard on the PS-250
- Shielded power transformers protect the system and users from non-ionizing radiation produced by the transformers.
- Built-in overload protection is contained on all outputs.
- Built-in overvoltage protection is provided on the main output.
- Remote sense capability on the main output provides the option to attach a remote voltage monitor to the Power Supply system.
- Vacuum impregnated magnetics are standard on the PS-250 Power Supply.
- A 24-hour HIGH TEMPERATURE BURN-IN is performed on all power supply units as a quality test.

Following are the electrical and environmental specifications for the PS-250 power supply:

INPUT: 90-132VAC/18VAC, 47-440Hz Inrush: 15A @ 115V for 1/2 cycle; 30A @ 230V for 1/2 cycle

OUTPUT: 250 watts (300 PEAK); 5V @ 35A, -5.2V @ 2A, 12V @

5A/8A PK, -12V @ 3A, 24V @ 5A/8A PK

LINE REGULATION: 0.2%, all outputs

LOAD REGULATION: 0.2%, main output; 5% aux no. 1; 0.5%,
aux no.'s 2 and 3

ADJUSTMENT RANGE: +/- 5%, aux no.'s 2 and 3 and main output

CENTERING: +/- 3%, aux no. 1

CROSS REGULATION: 3% aux no. 1 (change main output from
50% to 100% of max rated load)

RIPPLE AND NOISE: 50mV P-P max, main output (10MHz
bandwidth); 1% of nominal, aux no. 1 (10MHz bandwidth);
100mV P-P max, aux no.'s 2 and 3 (10MHz bandwidth)

EFFICIENCY: 75% typical

OPERATING TEMPERATURE: 0-50 degrees C at full rated load.
Derate to 50% of full rated load at 70 degrees C.

TEMPERATURE COEFFICIENT: 0.02% per degree C

OVERLOAD PROTECTION: All outputs are protected against
overload and short circuit conditions. Prolonged short
circuit condition on main output or aux no. 1 results in
system shut-down. System is reset by recycling input power.
Aux output no.'s 2 and 3 are foldback current limited.
Recovery is automatic when load is reduced.

OVERVOLTAGE PROTECTION: OVP on main output is set between
6-6.5V. This protection is reset by recycling input power.

HOLDOVER STORAGE: 16 milliseconds minimum at full rated
load, nominal input voltage.

TRANSIENT RESPONSE: Recovery to within 1% of nominal output
voltage within 500 micro sec for a 25% load step.

OVERSHOOT: No voltage spikes on turn-on, turn-off, or
power-fail.

REMOTE SENSE: Remote sense on the main output compensates
for up to 0.5V in the load cable.

1.3 Certification

The PowerFrame and its components have been certified or are in the process of being certified by the appropriate governing bodies. Following is a list describing the present state of the certification process:

FCC - The 2340 PowerFrame has been certified to meet the Radio Frequency Interference standards set by the FCC. The 7340 and 6840 models have been submitted for certification and are now awaiting approval.

UL - All components of the PowerFrame meet the UL fire hazard standards. The power supply has been submitted for certification and is awaiting approval.

CSA - The PowerFrame has been submitted to the CSA for certification. CSA is the Canadian certification agency.

VDE - VDE is the European agency for certification. At the present time, plans are being made to submit the PowerFrame to the VDE for certification.

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Installation and Service

1. Installation

The PowerFrame is a free-standing unit requiring very little effort to install. The details of removing it from the package, connecting terminals, spinning the disks up, etc., are explained in an installation guide.

2. Service

The factory provides excellent support of its products through INDESERV and the Federal Express PartsBank. INDESERV is a network of independent service companies providing field service and depot repair of data processing and communications equipment. Indeserv coordinates and administers the activities of individually owned and managed field service companies around the United States, Canada, and Puerto Rico. The individual Field Engineer works from his or her office to provide local coverage for specific needs.

Since most of their field engineers have had either civilian or military technical school training, INDESERV is able to provide high quality service. In addition, many of the field engineers have had training from many of the top mainframe and peripherals manufacturers. They have been trained in the repair of PowerFrame equipment. INDESERV provides on-site service, or for peripheral equipment, a depot service whereby the item is shipped to an INDESERV repair depot and shipped back after repair.

Replacement parts are available through the Federal Express PartsBank. The PartsBank, located in Memphis, stores PowerFrame replacement parts. Since they operate 24 hours per day, replacement parts can be on their way to a customer within 15 minutes of a phone request.

Because of the unique design of the system, when the technician arrives to repair your computer, he or she will simply replace the defective parts with new ones from the replacement parts set. If your technician has any problems which cannot be solved locally, the factory provides telephone and on-site support in order to get your system running again.

In addition to hardware support, the PowerFrame factory also provides software support. Telephone hotline service is available to help solve problems as they arise. Training in the use of

software packages is available, either on-site or in the factory training center.

APPENDIX - PCB SPECIFICATIONS

PDP-11/23+ CPU Board

Board Form Factor: Quad Height - Q-Bus
Relative Performance: 2.5 (based on the Falcon-Plus board = 1)
Floating Point: Optional
Memory Management: Yes
Additional
On-Board Functions: 2 Asynch SLUs, Boot/Clock, Q-Bus
Expansion Capability
Address Range: 4MB
Software: RSX-11M Plus, RT-11, RSTS/E,

PDP-11/73 CPU Board

Board Form Factor:	Dual Height - Q-Bus
Relative Performance:	7 to 8 (based on the Falcon-Plus board = 1)
Floating Point:	Yes
Memory Management:	Yes
Additional On-Board Functions:	Q-Bus Expansion Capability
Address Range:	4MB
Software:	RSX-11M Plus, RT-11, RSTS/E

Disk Controller

Board Form: Quad Height

Register Addresses:
(Prom Selectable)

(RKCS1)	777 440	Control/Status 1
(RKWC)	777 442	Word Count
(RKBA)	777 444	Bus Address
(RKDA)	777 446	Disk Address
(RKCS2)	777 450	Control/Status 2
(RKDS)	777 452	Drive Status
(RKER)	777 454	Error
(RKAS/OF)	777 456	Attention Summary/Offset
(RKDC)	777 460	Desired Cylinder
(RKXMA)	777 462	Extended Memory Address
(RKDB)	777 464	Data Buffer
(RKMR1)	777 466	Maintenance 1
(RKECPS)	777 470	ECC Position
(RKECPT)	777 472	ECC Pattern
(RKMR2)	777 474	Maintenance 2
(RKMR3)	777 476	Maintenance 3
(RKERTC)	777 546	Enable Real Time Clock Control

Data Transfer: DMA, 64K words maximum block size
transfer

Bus Load: 1 Standard Unit Load

Address Ranges: Disk Drive - up to 220.32 MB
Computer Memory - up to 2 megawords

Interrupt Vector
Address: PROM selectable, factory set at 210, (215 alternate)
priority level BR5

Disk Drive I/O:

Connector: One 60-pin type "A" flat ribbon cable mounted on
outer edge of controller module. Two 26-pin type
"B" ribbon cables (one for each drive)

interfaced with).

Signal: SMD A/B flat cable compatible.

Power: +5 volts at 3.5 amps, +12 volts at 300 milliamps from computer power supply.

Environment: 40 degrees F. to 140 degrees F. operating temperature. Humidity 10 to 95 percent non-condensing.

Shipping Weight: 5 pounds. Includes cables and documentation.

MULTIPLEXED I/O Board

Device Address: 760000 to 777776 octal - switch selectable
 Vector Interrupt: 000 to 776 octal - switch selectable
 Operation: Full-duplex
 Data Format: Program controlled, asynchronous, serial-by-bit
 Start Bits: 1
 Stop Bits: 1 or 1-1/2 (5-level codes only), or 2
 Character Size: 5, 6, 7, or 8 bits. Program-controlled. No parity bit.
 Parity: Odd, even, or none. Program controlled.
 Bit Polarities: Q-BUS DISK CONTROLLER EIA OUT
 Data Signal: Low = 1 High = 1 1 = Mark
 High = 0 Low = 0 0 = Space
 Control Signal: Low = 1 High = 1 1 = Off
 High = 0 Low = 0 0 = On
 Order of Bit: Transmit/Receive low order bit first.
 Break: Can be generated and detected on each line.
 Baud Rates: Program controlled. 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 7200, 9600, 19,200
 Throughput: 21,940 characters per second max,
 = (bits/seconds x number of lines x directions) /
 (bits/character)

Memory Board

Memory Device Type: 64K x 1	MOS dynamic RAM,
Read Access Time:	200 ns. typical
Write Access Time:	50 ns. typical
Memory Cycle Time:	450 ns. typical
Operating Temperature:	0 to +65 C
Storage Temperature:	-40 to +85 C
Relative Humidity:	0 to 90% non-condensing
Voltage Required:	+5V plus or minus 5% pins BU1, AA2, BA2
Battery Backup Voltage:	+5V plus or minus 5% pins AV1, AS1, AE1
+5V Operating Current:	2 amp typical
+5V Standby Current:	2 amp typical
+5V Battery Backup Current:	.9 amp typical

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