

The PDP-8

What is a PDP?

DEC, the Digital Equipment Corporation, was founded in 1957 by Ken Olson and Harlan Anderson. Initially, the company produced logic modules which were used in control systems and also for teaching. When they started making computers, in 1960, they used the term **Programmed Data Processor** (PDP) to describe their products, rather than the more usual term computer.

Why?

It was a question of image. By renaming their product, DEC avoided the impression that their machines were necessarily vastly expensive and required specialised buildings and staff to house and run them. Also, by directing their machines at scientists, rather than the business community, DEC were able to reduce their software and support costs to a minimum. Scientists enjoyed playing with the new toys and were happy to spend time developing their own programs. Consequently, DEC's early computers were sold at about one tenth of the cost of machines then currently on the market.

The first machine was the PDP-1, this was followed by the PDP-4, 5,6 7 and then the PDP-8.

PDP-8 Family Introduction

The PDP8 family of computers was produced by DEC between 1965 and 1990. During this time, the physical form of the machines changed considerably, but all the family had the same instruction set and programs written for one would work on another.

(As with all statements about computers, this last one is, of course, not completely true. There are quirky differences with some of the instructions, but generally speaking it's good enough).

The PDP8 family is **intriguing** for several reasons:-

- The family covers the period from discrete transistor machines (PDP-8) through integrated circuits up to the micro-processor (DECmates)
- The original PDP-8 has been described as the first personal, desk-top computer - (although the desk had to be a substantial one)
- The architecture is simple. They are twelve-bit machines with a limited instruction set.
- The early members have lots of switches and lights (always a good thing)

The family is **infuriating** because of:-

DEC's arcane numbering system and board descriptions! If you don't know already, you are about to find out.

The PDP8 family members, in a rough time sequence - some ran concurrently, were as follows:-

- PDP-8 - Introduced in 1965 - all transistor
- PDP-8/S - Serial version of the PDP-8 - cheaper but MUCH SLOWER
- PDP-8/I - integrated circuits
- PDP-8/L - simplified version of 8/I
- PDP-8/E - very successful - integrated circuit - printed circuit omnibus backplane
- PDP-8/F - very similar to the 8/e
- PDP-8/M - very similar to the 8/e

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- PDP-8/A - large scale integrated circuits
- VT-78 - the first micro-processor model
- DECmate I - the DECmates were marketed as dedicated word processors, but can run PDP-8 software
- DECmate II
- DECmate III - discontinued in 1990
- DECmate III+ - discontinued in 1990

PDP-8 The Computer.



***PDP-8 The Computer.
Inventory No: 0131***

The PDP-8 is the first member of the series, introduced in 1965. It was produced in two variant forms; one rack-mounted with 'rosewood' front panels and the other table-mounted, with smoked, plexiglass panels allowing a tantalising glimpse of the interior. The table mounted version was actually built into its own steel framework (the table!), with the CPU and memory mounted above the table-top and the power supply below. The rack mounted variant could have a 'winged table' to hold a teletype, this fitted just below the programmer's console.

The PDP-8 is largely built from DEC standard logic modules.

The illustration shows two cabinets (each one is 69 inches tall by 27 inches wide). The one on the right is the PDP-8, with its 'rosewood' panelling and the programmer's console below. This whole unit will slide forward out of the cabinet. This allows access to the processor (on the right) and the memory (on the left). When fully out, the two halves will then open rather like a book, giving access to the wiring of the backplanes.

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The basic PDP-8 consisted of this single cabinet; a processor with 4K words of memory, together with a ASR33 teletype. The teletype comprised a keyboard, a print unit, a paper tape reader and a paper tape punch. All these operated at 10 characters per second. The basic PDP-8 was programmed from paper tape read in from a teletype.

The cabinet on the left in the illustration holds two DECTape drives and a high-speed paper tape reader. These are not part of the basic machine. The basic PDP-8 could be extended, but extra peripheral devices required more cabinets.

PDP-8 The Processor Side



PDP-8 The Processor Side

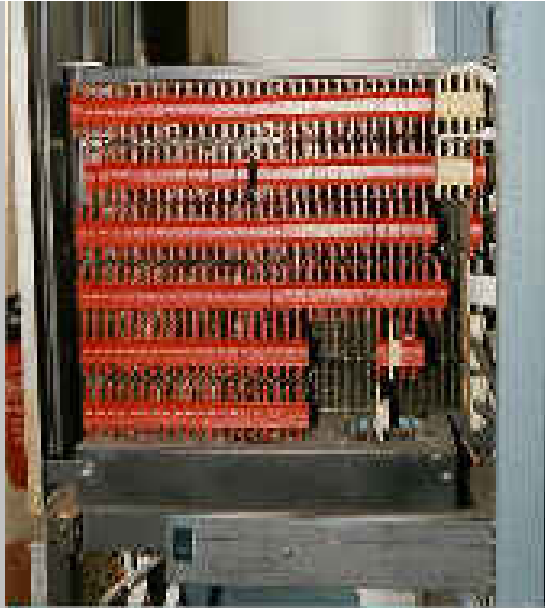
Here the unit has pulled forward out of its cabinet and we are looking at the right hand side (the processor). The edge of the blue cabinet can be seen on the right and the aluminium trim round the rose wood panel on the left.

This machine is almost completely populated, it only lacks the a/d converter, located in the gap, bottom, right of centre. At the right of the bottom two rows can be seen the black 92Ω bundled bus cables. Above these are ribbon cables connecting to the memory side and at the top the white wiring connects to the front panel lights and switches.

See processor side for a colourful diagram of a fully populated machine. There are six rows of cards from PA, at the top, to PF, at the bottom. Each row can accommodate 36 modules, which are numbered from 1, at the back, up to 36, at the front.

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PDP-8 The Memory Side

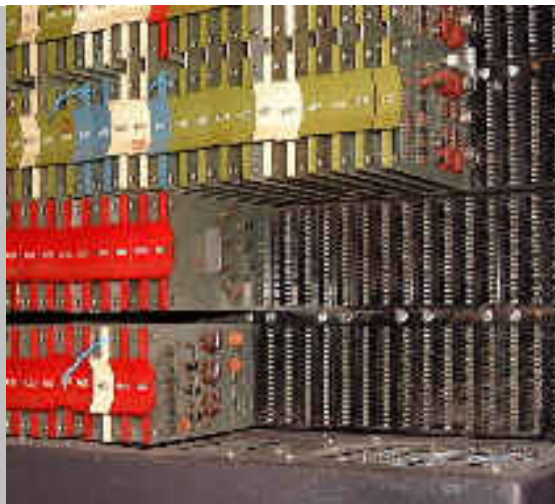


PDP-8 The Memory Side

Looking at the memory side. The black box in the centre of the top holds the core memory, 4K 12 bit words. The module locations are numbered in a similar way to the processor side. There are six rows, labelled MA at the top to MF at the bottom. The individual module positions are numbered 1, at the front to 36 at the back. Positions MA&MB 9-24 are occupied by the core.

See Memory side for a colourful diagram of the memory side.

PDP-8 The Memory Side - Detail

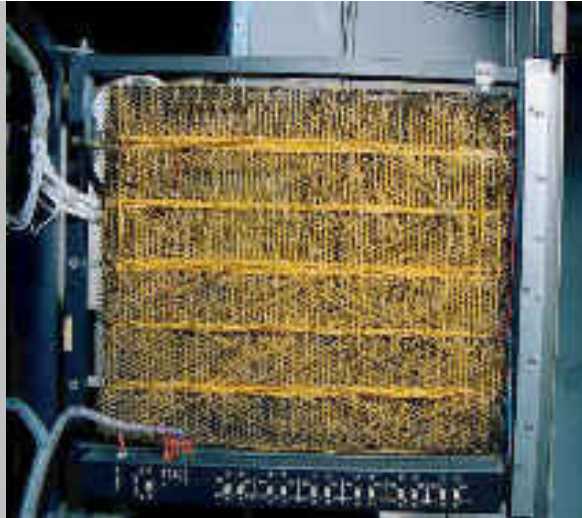


PDP-8 The Memory Side - Detail

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Some modules have been removed and the back plane can be seen. The rightmost module in the second row up (row ME position 16) is (yet) another S111 and the protruding block is the flip-chip module.

PDP-8 Processor Backplane.

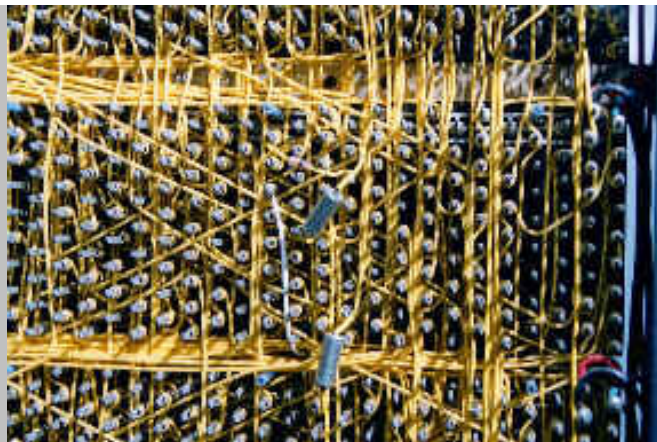


PDP-8 Processor Backplane.

When the unit has been slid completely out of the cabinet, the two halves will hinge apart, opening like a book. This reveals the two wire-wrapped backplanes. Note the complexity. There are 3888 individual connection points on the processor side. Note also that the geometry of the machine is fixed; all were, for instance, prewired for the a/d module.

Also visible at the bottom are a series of white switches. These are for marginal testing, and allow the supply voltage to be varied row by row to identify potentially faulty components.

PDP-8 Processor Backplane - Detail

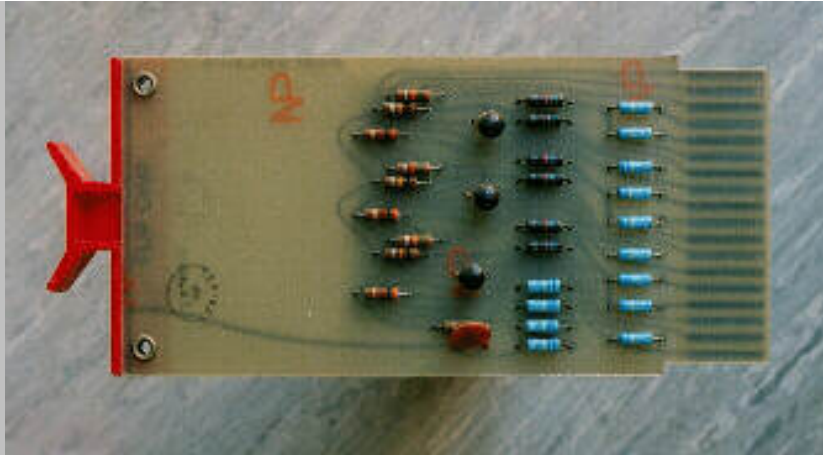


PDP-8 Processor Backplane - Detail

The PDP-8

A part of the mass of wire that is the PDP-8 backplane. This gives some idea of the complexity of the wiring, which contributed to a large proportion of the cost of the machine.

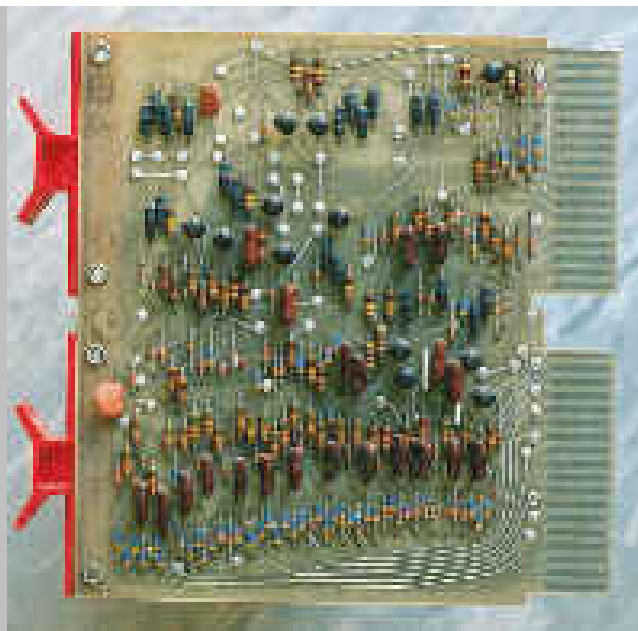
PDP-8 Circuit Modules - S111



PDP-8 Circuit Modules - S111

A typical module is the S111, three diode/transistor gates. The PDP-8 is largely built from logic modules such as these. These were the standard type of logic modules made by DEC in the days before they started making computers.

PDP-8 Circuit Modules - R210 Accumulator.

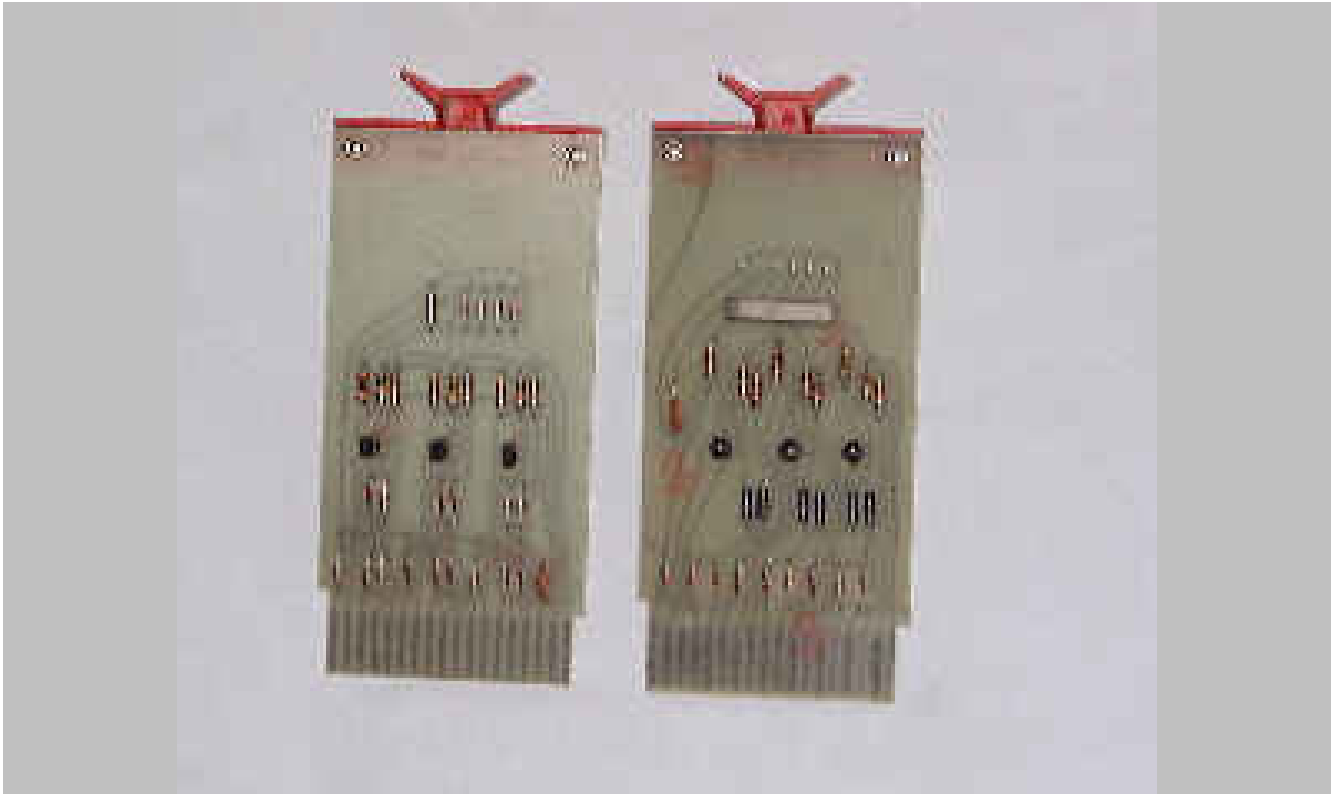


PDP-8 Circuit Modules - R210 Accumulator.

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There are 13 of these double height modules in a PDP-8, one for each of the machine's 12 bits and one for a bit called 'the link' (in modern terms, the 'carry'). This board is the most densely populated of the PDP-8's modules.

PDP-8 Flip-Chip Modules.



PDP-8 Flip-Chip Modules.

DEC made a lot of fuss about integrated circuitry in the PDP-8, which they called the Flip-Chip. Later, they applied the name to the modules as well.

But:-

There were no integrated circuits in the PDP-8.

The flip chip was no more than the encapsulation of 4 diodes and one resistor.

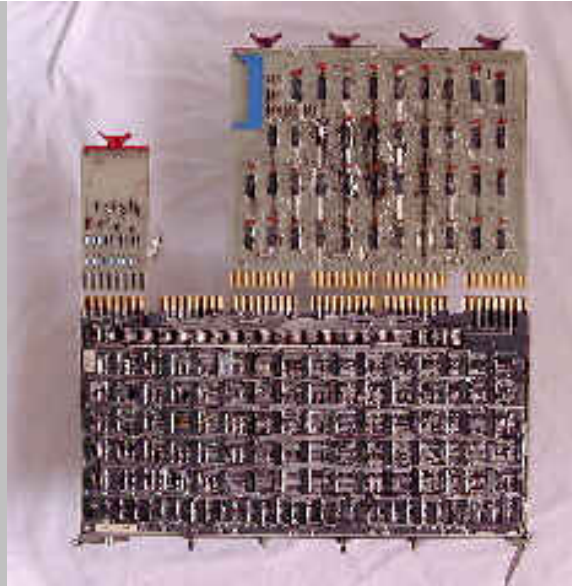
The picture shows two S111 modules. The one on the right has the FLIP CHIP 'integrated circuit', the one on the left is its discrete component counterpart. Notice that the board on the right still has the holes and circuit traces for the discrete components. The diode /resistor array was to provide a -3v clamping level for the logic.

For a circuit diagram of the S111 see S111 circuit. The diode resistor array is outlined by a dotted line on the right of the diagram.

There are many variants of these boards, note that the S111 shown in the previous box has its 4 diodes and the resistor incorporated with the gate circuitry.

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PDP-8 Family Circuit Boards.



PDP-8 Family Circuit Boards.

The photograph shows a single height board from a PDP-8, a quad height board from a PDP-8/E & a hex height board from a PDP-8/A.

Note: There is, unfortunately, one board type missing from this sequence. The PDP-8/I and PDP-8/L computers used single height boards which housed small scale TTL integrated circuits, rather than the individual components used on the PDP-8 board illustrated above.

PDP-8/E Computer.

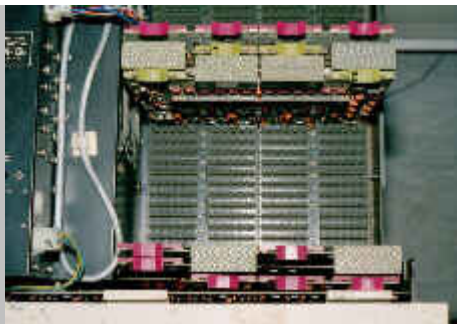


*PDP-8/E Computer.
Inventory No: 0002*

The PDP8/E was perhaps the most successful of the series. It introduced the OMNIBUS backplane in which equivalent positions in each slot were connected identically via a printed circuit. This was a more flexible design and much cheaper to implement.

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PDP-8/E Processor - Memory and Omnibus Backplane



PDP-8/E Processor - Memory and Omnibus Backplane

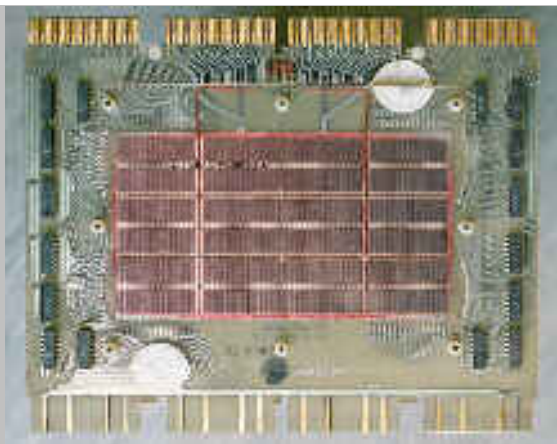
Looking vertically down onto the OMNIBUS. This is superficially similar to the PDP-8 backplane but each slot has double sided connectors. The bezel of the front panel is visible at the bottom of the photograph and the power supply is on the left.

The OMNIBUS backplane of the PDP-8/e consists of 2 separate blocks. Each could hold 20 boards, (although to jumper the boards together took 1 slot from each). In the photograph, only the front one is visible; the other, in fact, is not connected. All modules have been removed except the processor (the front three modules, M8330, M8310, M8300), the 4KW memory (G104, H220, G227) and bus terminator at the rear, M8320.

Slot 1 of the omnibus is always occupied by the programmer's console. This is just visible in the photograph, immediately behind the front panel. This holds the switches, lights and associated control circuitry for the console. It is not possible to remove this module without dismantling the front panel.

The rectangular blocks visible on top of the boards (2 on the CPU and 4 on the memory) are H851 inter-board connectors, connecting adjacent pairs of boards.

PDP-8/E Core Memory (4K words).



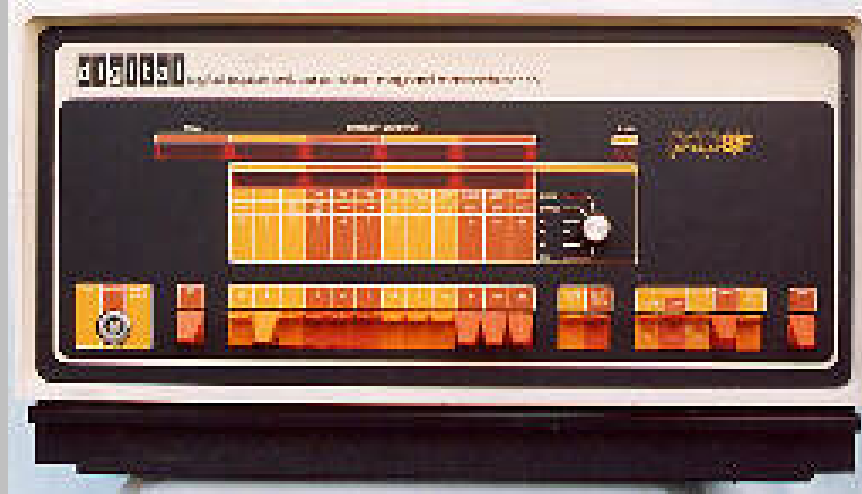
PDP-8/E Core Memory (4K words).

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The 4K core memory stack. In the centre, under a protective perspex screen, are 49,152 ferrite rings (12 × 4096) and each one has three wires threaded through it. The bundles of wires can be seen as the pinkish strands round the edge of the core.

The H220 module has connectors at the top and bottom of the board. Those at the top are for the inter-board jumpers to connect to the adjacent support modules, G104 and G227. Together, these three boards provide 4K 12-bit words of memory.

PDP-8/F Computer.



*PDP-8/F Computer.
Inventory No: 0190*

The PDP-8/F is a later and slightly reduced version of the PDP-8/E. The 8/F has a smaller and lighter switched mode power supply than the linear power supply of the 8/E. The OMNIBUS backplane of the 8/F is half the size of the 8/E's backplane, (10 slots as opposed to 20). The only other difference between the two machines is that the 8/F uses LED lamps rather than filament bulbs in the programmer's console.

PDP-8/F - Power Supply, Memory and Omnibus.

The PDP-8



PDP-8/F - Power Supply, Memory and Omnibus.

Looking down onto the opened computer. The smaller power supply can be seen to the left of the backplane. As with the PDP-8/E described above, the programmer's console occupies the first OMNIBUS slot. This is followed by M8330 (Timing Generator), M8310 (Major Register Control), M8300 (Major Registers). Slot 5 holds M837 (Memory Extension and Timeshare), this is necessary if more than one plane (4K) of core is fitted. Next comes M848 (Power fail and Auto Restart).

Two planes of core memory are present (8K words).

PDP-8/A Introduction.

The PDP-8/A is the final refinement of the bus based PDP-8s. The CPU (the KK8-A) now only requires one hex-high board. The omnibus is mounted vertically at the back of the case and circuit boards plug in horizontally.

There are two types of 8/A, depending on the type of memory fitted. The basic model was supplied with semiconductor memory, which was available in 1,2 or 4K word modules. This had a standard quad omnibus, like the PDP-8/e, but with only 10 slots.

The second type of PDP-8/A was fitted with core memory. Core memory was supplied in 8 or 16 K word modules. This required a 5 high omnibus.

The situation is complicated by the fact that some models of PDP-8/A were originally fitted with the PDP-8/e CPU (which is faster). The basic models are:-

| Computer | CPU | Memory | Omnibus | Floating Point FPP-8/A? | Expandable? |
|----------|-------|---------------|----------|----------------------------|-------------|
| PDP-8/A | KK8-a | Semiconductor | 10 Slots | No | No |
| 8A400 | KK8-A | Core | 12 Slots | No | No |
| 8A420 | KK8-A | Core | 20 Slots | No | No |

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| | | | | | |
|-------|-------|------|----------|-----|------------------------------|
| 8A600 | KK8-E | Core | 12 Slots | No | Yes, add up to 20 more slots |
| 8A620 | KK8-E | Core | 20 Slots | No | Yes, add up to 20 more slots |
| 8A800 | KK8-A | Core | 12 Slots | Yes | No |
| 8A820 | KK8-A | Core | 20 Slots | Yes | No |

The 800 and 820 models were fitted with the floating point option, FPP-8/A. In all other respects, they are identical to models 400 and 420.

PDP-8/A 400 Computer.



***PDP-8/A 400 Computer.
Inventory No: 0093***

The PDP-8/A console has been reduced to a keypad and 7 segment LED display. Keypad - detail (33776 bytes) By the time the PDP-8/A was produced it was possible to store bootstrap routines in ROM and the PDP-8/A has built-in routines for booting off several different peripherals. The programmer's console was no longer needed if these routines were used and so some machines were sold with the basic console only. This has a switch to start the boot process.

PDP-8/A 400 Inside the case.

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PDP-8/A 400 Inside the case.

With the console panels removed, we can see across the top of the case, the CPU board, option boards 1 & 2 and Core memory on the two siamesed boards at the bottom of the stack.

At lower left is the G8018 power supply and on the right the transformer for operation on UK voltages. Below this, the ribbon cable to connect to the basic console panel.

PDP-8/A 400 The Backplane.



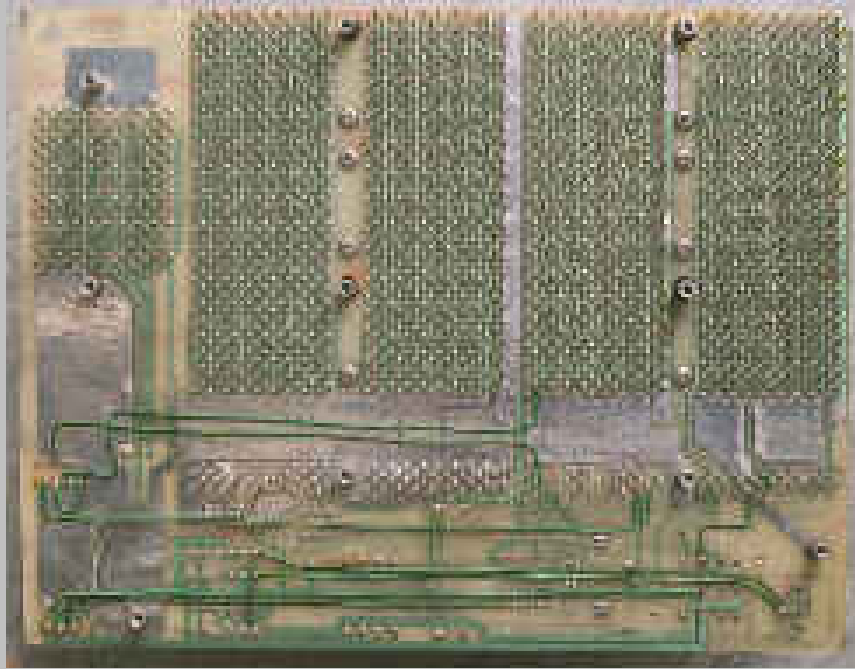
PDP-8/A 400 The Backplane.

The backplane, removed from its case. The omnibus is largely formed in one block and has an additional block of connectors tacked on to the side. Slots 1-3, which take the CPU and option boards 1 & 2 are quad, as are slots 9 to 12. Slots 4 to 8 have 5 sets of connectors and are for core memory. There does not seem to be an accepted term for these.

The isolated line of omnibus at the bottom is where the G8018 power supply PCB plugs in.

The PDP-8

PDP-8/A 400 The Backplane Wiring.



PDP-8/A 400 The Backplane Wiring.

The rear of the 8/a 400 omnibus. The four slot omnibus section of the illustration shows the rippling pattern of the printed circuit which interconnects the equivalent positions in each slot. Compare this with the wire wrapped backplane of the original PDP-8 and see why the omnibus implementation was so cost effective.

The fifth slot is on the upper left of the image and the power-supply wiring at the bottom.

(The PDP-8/e omnibus wiring is identical to the four slot omnibus section of this illustration).

PDP-8/A 620 Computer.

The PDP-8



***PDP-8/A 620 Computer.
Inventory No: 0102***

From the front, the PDP-8/A 620 looks identical to the 400 model (seen above), but from the side their differences are obvious. The 620 has a much deeper case. The reason for this is that boards fitting into the 20 slot omnibus take up all of the front of the unit and the power supplies (now 2 to accommodate increased requirements) are housed at the back of the case.

PDP-8/A 620 Inside the case.



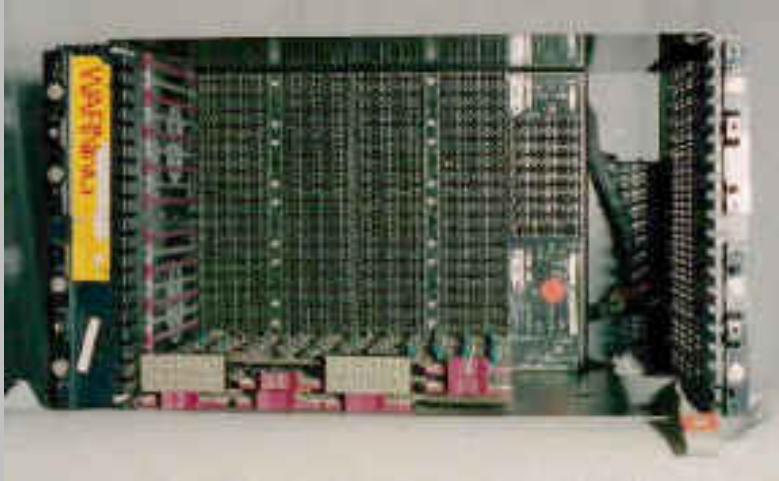
PDP-8/A 620 Inside the case.

Looking into the case of the 620. The first thing to notice is the presence of quad boards with MAGENTA handles! This machine is fitted with an 8/E CPU.

The CPU is fitted at the bottom of the case and the bus terminator is fitted at the very top.

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PDP-8/A 620 The Backplane.



PDP-8/A 620 The Backplane.

The 620 with most of its boards removed. Only the 8/E CPU remains at the bottom. Again, it can be seen that the omnibus is largely quad, but there is provision for core memory at positions 4 to 11.

PDP-8/A 620 The Rear of the Cabinet.



PDP-8/A 620 The Rear of the Cabinet.

The rear of the cabinet, with the two power supplies mounted one over the other.

The PDP-8

DECmate II



***DECmate II
Inventory No: 0013***

The DECmate II used the 6120 CMOS PDP8 on a chip and was quoted as having 64K word (12 bit) of memory. In fact 32KW of this was used to emulate missing PDP8 hardware.

In the basic machine storage was a dual RX50 5¼ inch diskette drive. A hard drive of (usually) 10MB was available as an option. Other options included an RX01/RX02 8 inch diskette drive interface and a Z80 processor with 64K bytes of memory, this was needed to run CP/M and also some of the more advanced software options (such as spell checking).

The DECmate II was promoted as a word processing system, running WPS, but it could also be used with other operating systems, notably OS278, which gives some of the feel of a PDP8 running OS8.

DECmate II SOFTWARE.

| Option | Product | Notes |
|-------------------|-------------------------------------|---------------------------|
| Word Processing | DECmate II/WPS | |
| Operating Systems | COS-310 Commercial Operating System | Includes DIBOL-8 Language |
| | CP/M 2.2 | Requires Z80 Option Board |
| Languages | MBASIC | Runs under CP/M |
| | R/M COBOL | Runs under CP/M |

The PDP-8

DECmate III



DECmate III
Inventory No: 0079

The DECmate III was the last of the PDP-8 line and along with the closely related III+, was discontinued in 1990. It uses the 6120 CMOS PDP8 on a chip and the same memory arrangement as the DECmate II.

While similar in many respects to the II, it is a more basic machine, lacking the II's expandability. Storage is limited to a dual RK50 5¼ inch floppy disk drive. There is a configurable serial communication port and a serial printer port fixed at 4800 Baud. For all its shortcomings, the DECmate III is a very pleasing and well proportioned design.

(The DECmate III+ had a single RX33 5¼ inch floppy disk drive and a 20MB hard disk)

The PDP-8

DECmate III - The Main Circuit Board.



DECmate III - The Main Circuit Board.

The DECmate III processor and memory, all on the same PCB, approximately the same size as a quad omnibus board.

DECmate III Plus



***DECmate III Plus
Inventory No: 0190***

The end of the line, the last of the PDP8 family, the DECmate III Plus with its single RX33 5¼ inch floppy disk and hard disk drive. In this particular example, the 'DECmate III' inscription is damaged and the blue is worn off the final I, making it appear as 'DECmate II'.

The PDP-8

DECmate III Plus opened



DECmate III Plus opened

The DECmate III with the casing removed showing the siamesed circuit boards and the RX33 drive mounted above the hard disk drive.

DECmate III carrying handle



DECmate III carrying handle

The DECmate III and the III Plus had a folding carrying handle at the rear of the case. When folded down and locked into position this handle acted as a restrainer for the video and coms cables of the machine.

The PDP-8

DECmate III cable restraint



DECmate III cable restraint

The handle locks into position when folded down and relieves strain on the connectors.