digital pdp14

programmable controller

product summary

digital equipment corporation

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PDP-14 AND PDP-14/L PROGRAMMABLE CONTROLLER

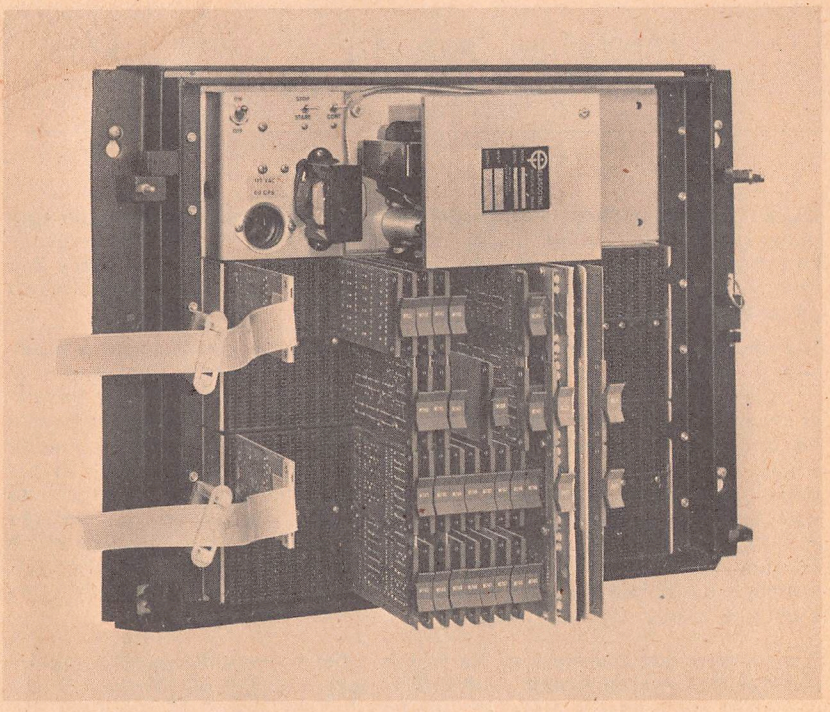
CONTROL PRODUCTS

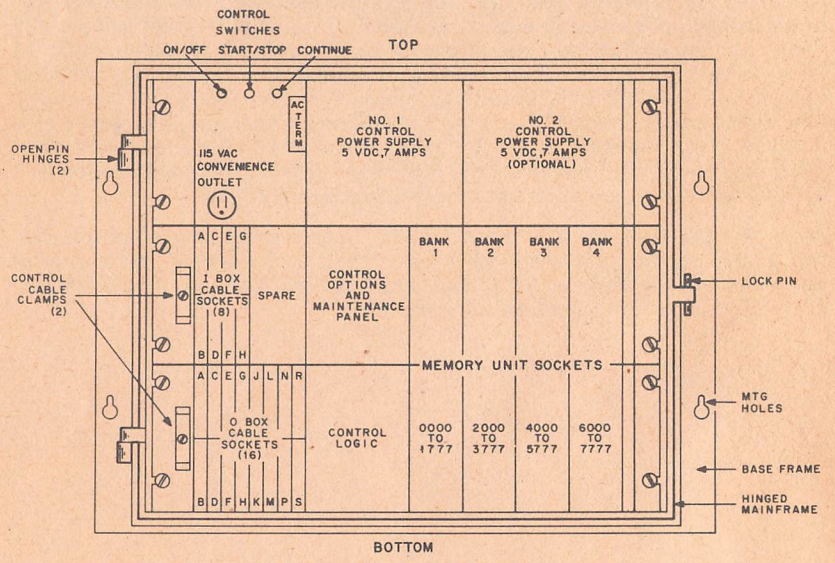
Digital Equipment Corporation's PDP-14 is a programmable solid state controller which is well suited to a variety of applications. The PDP-14 combines the advantages of solid state with the relay characteristics of simplicity and ease of use. It offers solid state logic in an easily programmed system which will operate in an industrial environment.

The basic PDP-14 Controller resembles a computer in that it contains input-output interfaces, a control unit and a memory. However, there are several important differences. First, the control unit is simplified and may be programmed using a few simple instructions. This allows a control engineer who has had no prior computer training to program the PDP-14. Second, the input-output interfaces are designed to accept 120 Vac line inputs, such as are field-wired from limit switches, and the outputs are similarly 120 Vac with sufficient capacity (500 Va) to drive solenoids or motor contractors. Third, the PDP-14 memory is nonvolatile; it is a hard-wired, read-only memory which contains the programmed instruction to control a specific application. Although the memory cannot be destroyed electrically, it can be altered by the insertion of a new set of wires.

The software and hardware of the PDP-14 offer a ready means of computer monitoring a control system. The PDP-14 serves as the AC interface to the controlled equipment. A computer interface between a PDP-14 and a PDP-8/I or 8/L general purpose computer is available. This computer interface permits the monitoring computer to interrogate inputs and outputs through the PDP-14 on a "cycle-stealing" basis. Using this technique, the monitoring computer may isolate component failure bringing downtime for repairs to a minimum. When necessary, the PDP-14 and the monitoring computer may communicate through 12 bit registers contained within the PDP-14. The monitoring computer may supply information to the PDP-14 which will affect its operation or it may supply actual instructions to be executed by the PDP-14.

The PDP-14 is designed to be more reliable, more flexible and, in most cases, less expensive than any other electrical system now available for control of machines and systems utilizing two state devices such as limit switches, pushbuttons, motor contactors and solenoids.





PDP-14 Mainframe

The PDP-14 system is all solid-state, and inherently reliable because of two key factors.

a. **The K Series industrial control modules.** For several years, the K Series has been widely accepted by industry as the most reliable solid-state module series available at reasonable cost. The rugged and flexible K Series has been designed into many types of custom control systems where speed and reliability are demanded. It is now available to serve the control needs of the mass-production industry as part of the PDP-14 system.

b. **DEC experience as leader of the small-computer field.** Switching circuits in a computer must function reliably hundreds of thousands of times a second. We have applied our knowledge of solid-state design and programming techniques to the PDP-14.

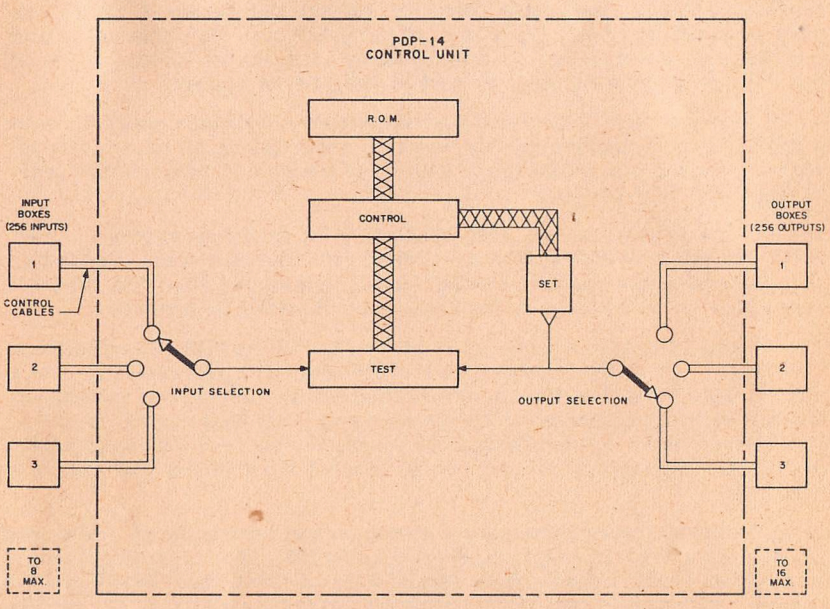
The PDP-14 system was designed specifically for industrial control. It is an integrated group of plug-in modular components. This allows the user to buy only the equipment actually needed for his control function. The modular approach also allows components to be easily replaced if necessary.

The "memory" used is a matrix of wires, inserted in the PDP-14 Control unit. This matrix is directly analogous to the wiring used in relay panels — but much smaller. It directs the entire operation of the PDP-14, and is designed by each user for his specific control needs, using a flexible computer program. This memory is so inexpensive that if changes in your manufacturing dictate new control operations, you can simply discard the memory and design a new one.

Large industrial relay control panels have a normal service life of two to five years, and then must be replaced entirely. During this period, individual relays and contacts must constantly be replaced. In contrast, the PDP-14 has no moving parts, and its components have a normal life expectancy of over ten years.

The PDP-14 system initial cost is about the same as relay systems, and for large control applications, is even less. In ten years of manufacturing, you could wear out three relay systems, and the PDP-14 should still be functioning reliably. Maintenance costs are reduced. And if the machinery is ever refitted for a new task, you don't have to start from scratch; just replace the PDP-14 memory.

As added bonuses, the PDP-14 system requires far less power and as little as one-tenth the space of conventional systems.



PDP-14 System Diagram

PDP-14 System Components

The PDP-14 Control System is a unified assembly of three basic units:

a. Input Interface Boxes ("I" Boxes)

b. The PDP-14 Programmed Control unit

c. Output Interface Boxes ("O" Boxes)

All system inputs and outputs are designed for 120 volts AC, 60 Hz, single-phase, compatible with the present industry standard.

INPUT BOXES

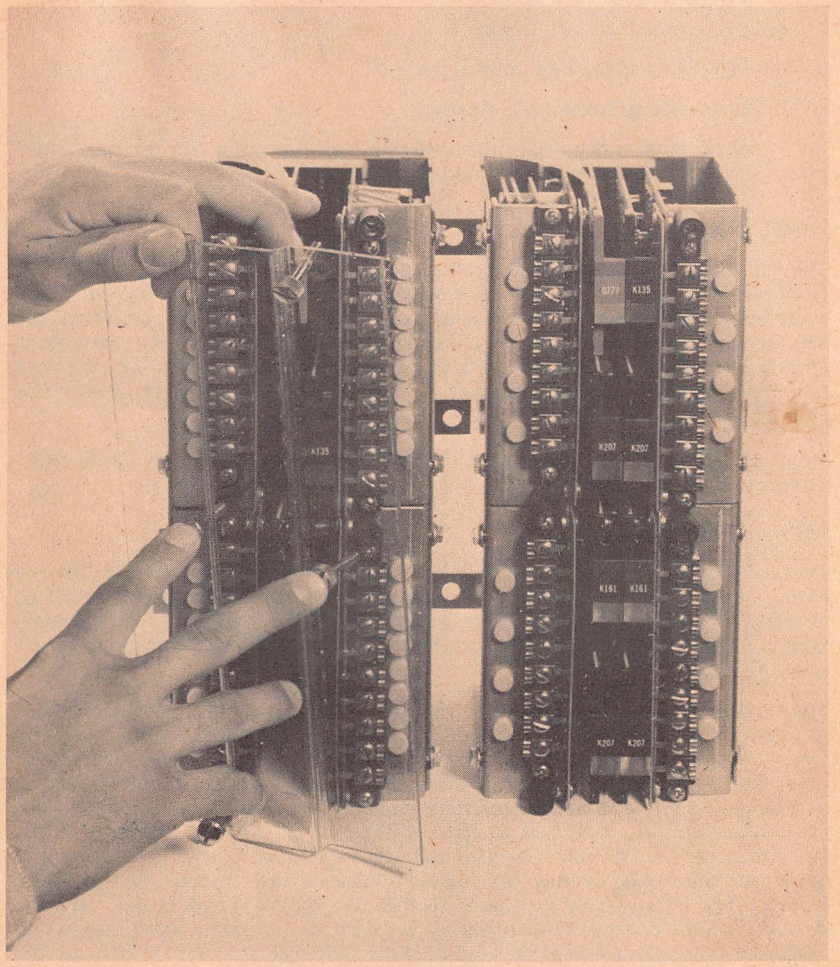
The "I" boxes are signal-conditioning devices; they accept 120 VAC inputs from two-state sensing devices such as limit switches, push buttons, proximity switches, pressure switches, and photo-cells. These inputs are converted into signals which are proper for our solid-state equipment. They then pass along control cables to the PDP-14 Control unit. Each I-box contains 32 inputs. A maximum of eight I-boxes, providing a total of 256 inputs is permitted in one PDP-14 system.

Input boxes may be substituted for output boxes to expand the input capabilities (in increments of 32) to a maximum of 512 inputs.

PDP-14 CONTROL UNIT

The control contains a wire matrix or "braid", which is the memory of the entire unit. It is called a "read-only memory," or "ROM" because it cannot be altered electrically (that is, "written on"). The ROM is actually a list of permanently wired electrical instructions which are "read" by the control to determine its operation.

The control operates in a way analogous to scanning a relay ladder diagram rung by rung. Each rung of the ladder represents a specific group of sensed input conditions which must be satisfied to cause a change in the condition of an output. The ROM contains instructions in small groups, each corresponding to a single rung in the ladder. The ROM directs the control to select each input specified in a group and test whether it is on or off. (This is the action performed by the "Test" unit shown.) Finally, the specified output is selected and set on or off, based on the test results. (This is the function of the "Set" blocks.) The control now continues to the next group of inputs and outputs, and repeats the process. This action proceeds one instruction at a time, but so fast that all inputs are checked and outputs properly changed in thousandths of a second; in fact, usually faster than one or two control relays could respond.



PDP-14 Input and Output Boxes

OUTPUT BOXES

Control signals sent from the control are accepted by the "O" boxes to activate selected 120 VAC outputs. Each output is a triac, the solid-state equivalent of a remotely controlled switch. Once set on, each output remains on and supplying power until it is set off by a new control signal.

Output boxes have an additional system function; they can be interrogated by the control unit to determine whether their outputs are on or off. In this mode, they can be considered as control inputs.

Each output of an output box can be connected to its own source voltage and to loads, such as solenoids, motor contactors, small motors, lamps and signalling devices.

Each output box contains 16 outputs. A total of 16 O-boxes providing 256 outputs may be incorporated in one PDP-14 system.

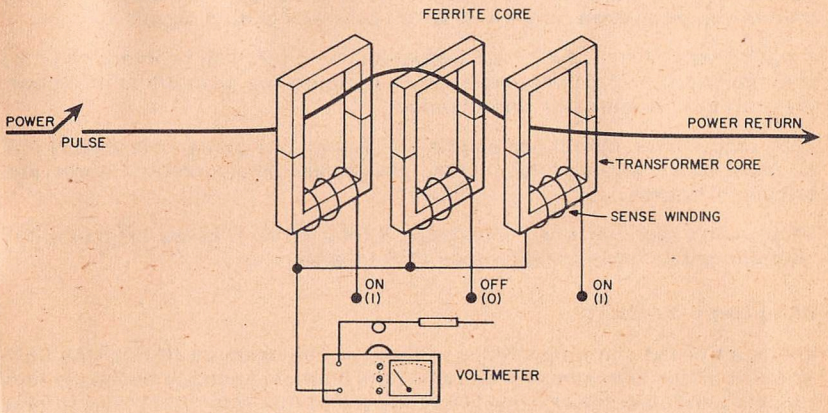
READ-ONLY MEMORY

The heart of the control operation is the read-only memory (ROM). The ROM contains all the instructions which allow the Control to sample specific groups of inputs and then select a specified output and turn it on or off. The ROM is provided in one to four separate plug-in sections, each of which has over 1,000 "locations" in which control instructions are stored. The number of sections required is determined by the size of the control "problem" — the number of inputs and outputs, and the number of control decisions which must be made.

The ROM is an actual physical matrix or "braid" of solid wires permanently embedded in a potting compound and surrounded by electronic sampling circuits (96 transformer cores) in a "sandwich" packaging. The arrangement of the braid wires is determined in a series of computer-aided steps, which result in a punched paper tape. This tape is used to operate an automatic wire placing machine, or "loom," which forms a wire braid. This braid, returned to be installed in the Control unit, represents the specific solution to the individual control problem. Whenever this element is changed, the PDP-14 System behaves as though it were rewired, allowing you complete flexibility in changing machine operations and retrofit.

In operation, the ROM acts like a series of wires strung through and around small current transformers. Each wire represents eight individual control instructions, which are read by sending a current pulse through it. The read out is in groups of eight instructions. The single desired instruction is selected from these eight. Only the transformers with wires running through their cores will be energized. The pattern of energized transformers is then read as an electronic instruction code. The code is the 12-bit binary instructions which are understood by the PDP-14 control unit.

It is possible to change as many as 20 wires (approx. 15%) of the ROM by cutting out wires and manually replacing them with new ones.



Schematic Of Three PDP-14 ROM Transformer Cores

ACCESSORIES

In addition to normal outputs, the PDP-14 system may be equipped with solid state timers, retentive memories, and storage outputs. The timers and retentive memories are provided in an accessories box (A-box). The storage outputs are provided in a storage module consisting of 16 storage outputs.

The solid state timers may be adjusted to provide timing functions from fractions of a second to thirty seconds. The retentive memories are mercury-wetted relays which provide 1-bit of storage information after a power failure. The storage outputs provide temporary storage of intermediate processing results, status information, and are sometimes used for communication between the PDP-14 and the monitoring computer.

Also supplied as an accessory is an auxiliary power supply which is required for large PDP-14 systems.

PROGRAMMING THE PDP-14

Programming in the PDP-14 system is simply the procedure used to generate the read-only memory (ROM) to control a process or machine. PDP-14 programming does not require previous computer experience; it does require experience in machine control.

PDP-14 programs provide relationships between inputs (limit switches, push buttons, selector switches, etc.) and outputs (solenoids, motor contactors, indicator lights, etc.). These relationships, or control functions, may be expressed as Boolean equations which, when solved for particular input values, specify the state (ON or OFF) of an output.

Machine inputs and outputs must be assigned to the PDP-14 input (I) and output (O) boxes before a PDP-14 control program can be written. These assignments permit the PDP-14 instructions to test the state of specific inputs and outputs. Once these assignments are made, the inputs and outputs are referred to by unique numbers preceeded by an "X" for an input, or a "Y" for an output. For programming purposes, these X and Y numbers represent specific input and output devices.

BOOLEAN REPRESENTATIONS OF MACHINE CONTROL

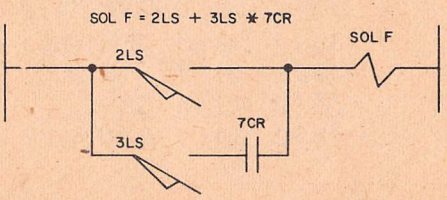
Programming a PDP-14 requires familiarity with simple Boolean representations of control functions. These representations are comprised of "operators" and "variables". The variables of PDP-14 control equations are inputs (X's) and outputs (Y's). The variables have two "states", namely, ON and OFF. The operators in these equations are * (AND), + (OR) and / (NOT). Parentheses may be used within equations to group variables.

For example, the equation:

$$Y10 = X23 + X21 * Y7$$

is read "output 10 is set ON when input 23 is ON, or when both output 7 and input 21 are ON." This equation instructs the PDP-14 to test input 23; if it is ON, set output 10 ON. In input 23 is OFF, test output 7 and input 21; if they are both ON, set output 10 ON. If neither set of conditions is satisfied, set output 10 OFF.

The above equation could be represented by the following familiar ladder diagram:



where SOL F corresponds to Y10; 2LS corresponds to X23; 7CR corresponds to Y7; and 3LS corresponds to X21.

A set of control functions similar to the preceding example comprise a PDP-14 program. A series of equations corresponding to these functions and written in terms of X's and Y's are then translated into the PDP-14 machine code program using BOOL-14.

BOOL-14

BOOL-14 is a translator program for control equations. It operates on a PDP-8 family computer and translates the equations into the PDP-14 machine code instructions needed to solve these equations. The machine code instructions will later be woven to form the ROM for the PDP-14. Before this happens however, the program should be rigorously tested and debugged. This is done with SIM-14. The translation for two equations is:

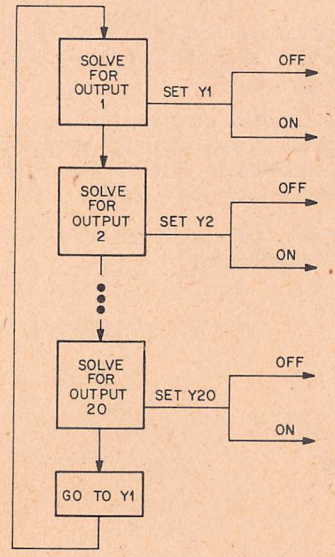
```
Y10=X23+X21*Y7

0000  2423  TXN  023
0001  5407  JFN  007
0002  2021  TXF  021
0003  1007  TYF  007
0004  5007  JFF  007
0005  3010  SYF  010
0006  0344  SKP
0007  3410  SYN  010

Y17=X2+X51+X3*Y7+X4*Y21

0010  2402  TXN  002
0011  2451  TXN  051
0012  5423  JFN  023
0013  2003  TXF  003
0014  1007  TYF  007
0015  5023  JFF  023
0016  2004  TXF  004
0017  1021  TYF  021
0020  5023  JFF  023
0021  3017  SYF  017
0022  0344  SKP
0023  3417  SYN  017
```

The resultant PDP-14 program is a "closed loop" of disjoint instructions groups. Each group of instructions solves an equation for one output, setting it on or off. For example, if a machine control requires twenty outputs, there are twenty equations and instruction groups in the control program. The last instruction group is terminated with a "jump" to the first instruction group. The following diagram illustrates the construction of the program.



SIM-14

SIM-14 is a PDP-8 based program which simulates PDP-14 operation in two modes. The user may operate in an offline or "local" mode to debug or modify his program completely within the PDP-8. When relatively certain that the program is correct, the user may switch to on-line mode where the program is executed to control the machine's operation.

Local mode debugging offers three features for testing programs.

1. The user supplies input states for a given equation and SIM-14 reports the resultant state of the output. This proceeds equation by equation.
2. The user generates a complete truth table, or binary array, which completely defines the state of an output for all possible input states. This is also done for each equation.
3. The user tests the complete program using simulated execution. He tests the complete program in sequence by specifying input states. Changing output states are reported by SIM-14. The user continues to vary input values to test all segments of the program.

The following are sample truth tables as generated by SIM-14 for the two equations which were translated by BOOL-14.

Y10 = X23 + X21 * Y7

```
.TA10
.X23
.X21
.Y7
.SØ

A  XØ23
B  XØ21
C  YØØ7

ABC
ØØØ=Ø
ØØ1=Ø
Ø1Ø=Ø
Ø11=1
1ØØ=1
1Ø1=1
11Ø=1
111=1
```

A X002
B X051
C X003
D Y007
E X004
F Y021

ABCDEF

000000=0
000001=0
000010=0
000011=1
000100=0
000101=0
000110=0
000111=1
001000=0
001001=0
001010=0
001011=1
001100=1
001101=1
001110=1
001111=1
010000=1
010001=1
010010=1
010011=1
010100=1
010101=1
010110=1
010111=1
011000=1
011001=1
011010=1
011011=1
011100=1
011101=1
011110=1
011111=1
100000=1
100001=1
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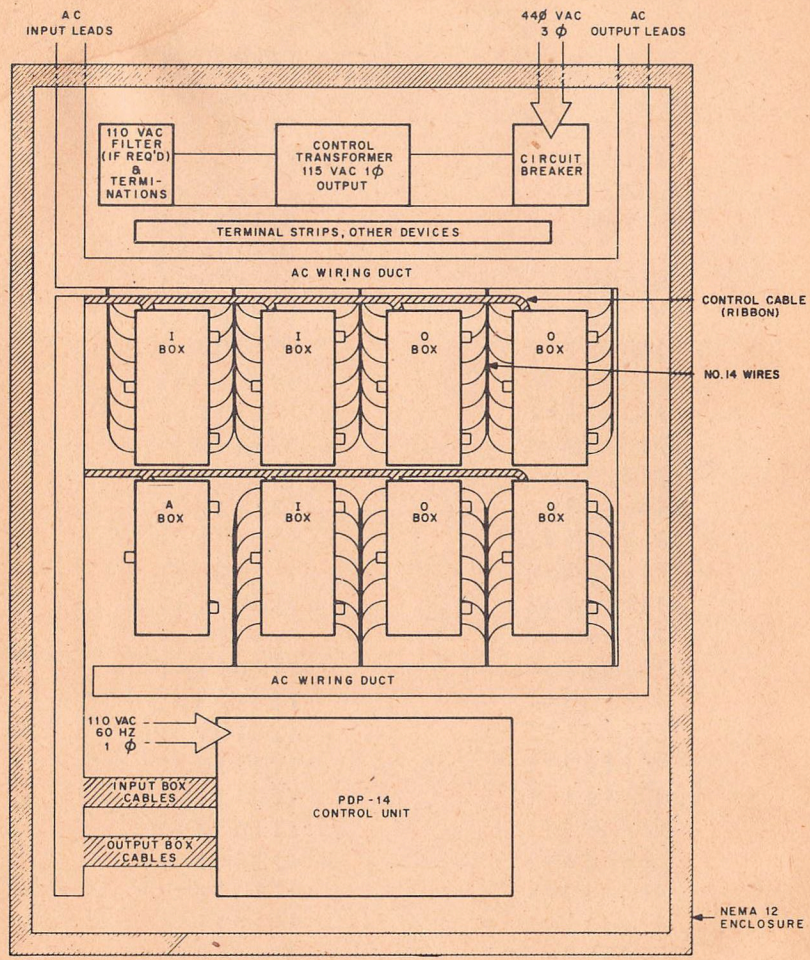


PDP-14 System Layout Example

PDP-14 SYSTEM EXAMPLE

What are the procedures involved in designing and maintaining a PDP-14 system?

- Configuring the system and selecting hardware
- Developing the control program
- Installing the hardware
- Debugging the system
- Installing the ROM
- Maintaining the system

All except the first of the above steps are assisted by software provided by DEC.

Configuring the System

How do you decide what PDP-14 hardware you will need to solve your control program? You must answer the following questions.

1. How many real outputs (motor contactors, solenoids, lights, etc.) are required?
2. How many timers are needed?
3. Must the PDP-14 record information with storage outputs or retentive memories?
4. How many inputs (limit switches, push buttons, selector switches, pressure switches, etc.) are in the system?
5. Will the PDP-14 be monitored by an external computer?
6. How many variables are in an equation to control a typical output?

Question 1 determines the number of output boxes required. Let's assume there are 72 outputs. (If a relay system is being changed over to PDP-14, control relays should be excluded from this count.) These 72 Outputs require 5 output boxes and leaves 8 spare outputs.

Question 2 concerns the selection of accessory boxes. An "A-box" can contain 16 timers. Let's assume there are 12 operations which must be timed. You need one A-box and 6 timer cards (each provides 2 timers).

Question 3 also concerns the A-box, if retentive memories are needed. Retentive memories are available as one mercury-wetted relay per card. Only 4 retentive memories may be used in one A-box, and each uses two output slots. Let's assume no retentive memories are needed. However, there are 7 status conditions which must be recorded (similar to the old control relay), and 5 push buttons, the activation of which the PDP-14 must remember after the input is no longer present. These require 12 storage outputs or one storage module with 4 spares.

Question 4 is a straight forward count of two state inputs. Each position of a selector switch is considered as a single input. Let's assume there are 91 inputs. Thus 3 input boxes are required, providing 96 input slots, five of which are spares.

Question 5 has several implications. The obvious need is a computer interface. However if the PDP-14 is to be monitored, several other considerations are also needed. Storage outputs may be required for communication between the PDP-14 and the monitor. More memory may be needed to handle monitoring information. Let's assume that the monitor will simply check inputs and outputs on a cycle-stealing basis and that there will be 5 status words sent from the PDP-14 to the monitor. The requirement is for approximately 25 extra PDP-14 locations.

Question 6 is probably the toughest to answer. It is aimed at an estimate of the amount of PDP-14 memory required for the system. If equations on the average contain 5 variables (e.g. Y1 = (X2 + X3 + X4) * X5), or more, a good estimate is that it will require 2N PDP-14 memory locations to solve the equation, where N is the number of variables. For less than 5 variables, 2N + 2 is the suggested estimating rule.

Let us assume there are on the average 7 variables in an equation (N = 7). We have 72 output equations, 12 timer equations, 12 storage output equations, a total of 96 equations each requiring approximately 14 PDP-14 (2N) locations. Thus, the memory requirement is 1344 locations (96 x 14). We also needed 25 locations to handle the monitoring needs. Thus a 2K (2000 location) memory is needed.

There are several trade-offs which may be made when configuring a system. Unused outputs may be used as storage outputs; programming (subroutines) may replace other storage outputs; monitoring systems may adjust the amount of processing done in the PDP-14 with the amount done in the monitor to vary the amount of memory required; excess memory may be used to diagnose equipment failures by turning on signal lights when inputs are found to be in the wrong state.

Developing the Control Program

The PDP-8 computer is used to run BOOL-14 and SIM-14 to write the PDP-14 control program. If the PDP-14 program will require greater than 1K of memory (1000 locations), an 8K PDP-8 is needed to develop the program. For programs of 1K or less, a 4K PDP-8 is sufficient.

The steps involved are:

1. Assign each input and output to a specific PDP-14 I or O-box and obtain the X and Y number.
2. Write the Boolean equations for each output using the X and Y numbers for inputs and outputs.
3. Type the equations on the Teletype.
4. Use BOOL-14 to generate the machine code program.
5. Read the machine code program into SIM-14.
6. Use local mode of SIM-14 to verify the instructions for each equation, by varying the input and recording the resultant output value; generate

truth tables for each equation; use simulated execution to test the whole program without attaching the PDP-14. SIM-14 will later be used to debug the complete hardware/software system.

Installing the PDP-14 Hardware

The PDP-14 hardware is installed within a standard NEMA 12 enclosure. The PDP-14 control unit is mounted near the bottom of the enclosure with the cables connecting it to the input, output, accessory and storage boxes. These boxes are usually mounted above the PDP-14 but still within the NEMA enclosure.

The required 110 VAC power is supplied to the processor directly. The I and O-boxes must be supplied independently with 110 VAC at each terminal either from an input, (e.g. limit switch) or to be switched to an output (e.g. a solenoid). The field wiring to the input and output boxes may be direct or via terminal strips within the NEMA 12.

The PDP-14 system when installed may be thoroughly checked to ascertain that no damage to the circuitry was received during shipment using TEST-14, a PDP-8 based diagnostic program. This program operates on a 4K PDP-8 and exercises all of the internal PDP-14 logic and contains options for testing the I and O-boxes. Failures cause message typeouts on the teletype console indicating which test the PDP-14 failed. The documentation provided indicates which module or modules may be defective, and the priority in which they should be checked. A defective module may be replaced in seconds.

If the I and O-box circuitry is to be tested, the field wires to the O-boxes should not be connected. Field wiring to inputs which directly turn on other devices should also be disconnected.

Once the PDP-14 has been thoroughly tested (one pass through the test takes approximately 3 minutes), the field wiring, if not already in place, is completed to the I and O-boxes and the complete system is debugged.

Debugging the System

When the program has been written and debugged and the hardware is installed, the system is debugged using online mode of SIM-14. In online mode, the PDP-14 program, which has been thoroughly debugged in local mode of SIM-14, is supplied to the PDP-14 and executed. The machinery will operate under SIM-14 as it will when the ROM is installed except that the PDP-14 will check inputs and set outputs at a significantly faster rate when its program is stored in the ROM. (This difference in processing speed between online mode and the ROM will not be a factor in most applications and can be counteracted, if necessary, through use of software subroutines.)

Bringing up a system that is to be controlled by a PDP-14 is considerably easier than a relay controlled system, because of the features of online mode and the terminal lights of the I and O-boxes. Wiring errors are easily detected by looking at indicator lights. If an operation does not occur, a glance at the lights indicates which input or inputs is not present. Using SIM-14, the state of storage outputs, timers, and retentive memories may be determined. Quick patches may be made to the program if problems are discovered. Check out progresses at a considerably improved pace because of the PDP-14 hardware and software.

The PDP-14 program may be executed in online mode in sections, using strategically placed "program stops" at which point execution of the PDP-14 program halts and control returns to SIM-14. Shut-down sequences or "stop equations" that are executed before control returns to SIM-14 may also be used in online mode. Thus the PDP-14 program may be run in total, or if desired, in parts thereby testing each individual programmed operation.

Installing the ROM

Once the system has been checked-out and the program is correct, a paper tape is punched from which DEC will weave a ROM. The ROM will be returned to you in two to three weeks. During that time the PDP-14 may continue to operate in online mode of SIM-14 and thus the controlled equipment may still be operated.

Once the ROM (or ROM's, if a greater than 1K program is used) has returned, it is plugged into the PDP-14 mainframe. The PDP-8 interface cables for SIM-14 online mode are removed, and the PDP-14 system is complete.

Field rewiring can change any instruction in the program after it is woven in the ROM. The procedure is simply to clip the lead from the old wire, and solder a new wire in its place. The new wire is then placed through, or around, the series of transformer cores to represent the correct instructions. If more than 15% of the programmed instructions must be altered, the rewiring may become cumbersome and a completely rewoven ROM should be considered.

A PDP-8 based program, VER-14 may be used to verify that the memory contains the same instructions as contained on a paper tape. Thus a program change should be made using SIM-14 and a new tape generated. (The change should, of course, be tested in local and online modes of SIM-14 first.) The wires may then be replaced in the ROM. When the ROM is re-installed in the PDP-14, VER-14 may be used to verify that the changes were properly made.

Maintaining the System

Once a system has been installed it may be maintained in several ways. When a failure occurs, it must be diagnosed to be in one of three areas:

(1) the controlled machine

(2) the input, output accessory boxes or The Storage Module

(3) the PDP-14 control unit

Assume that the failure may be characterized as, "this should happen now, but it doesn't!" Examining the input and output lights, it can easily be determined if the output to start the operation is present and if the inputs required to activate this output are present. If the output is on, the problem is in the machine; if the output is off and an input required for that output is missing, the problem is in the machine. If all inputs are present and the output is missing, the fault can be either in the PDP-14 I and O-boxes or in the PDP-14 control unit.

Once it has been determined that the failure is in the PDP-14 part of the system, the isolation of the failure to either the I and O-boxes or the PDP-14 processor itself is achieved by assuming that the I or O-box is at fault. The I and O-boxes may be checked out by swapping the modules concerned with the faulty input or output. Spare part kits are available for this purpose. If

module swapping in the interface boxes does not resolve the problem, the PDP-14 processor must be considered at fault.

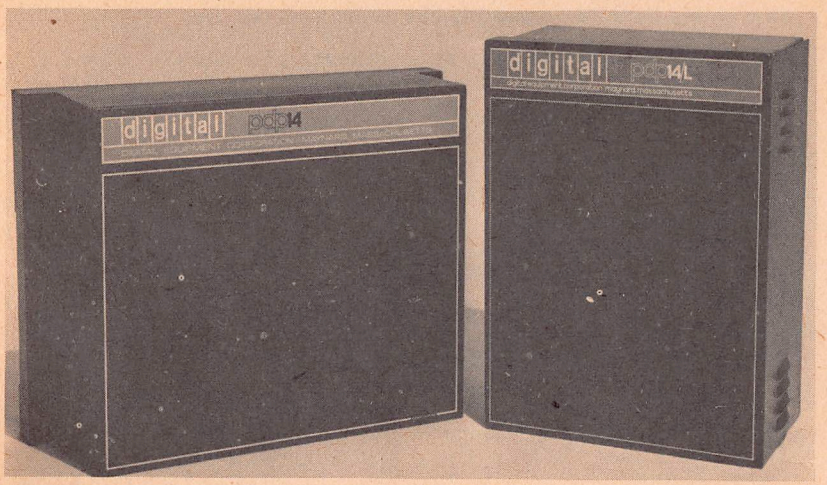
The processor may be checked out with TEST-14, the PDP-8 based diagnostic program to ascertain that the PDP-14 circuitry operates properly. If TEST-14 does not point out any electronic failure, the ROM memory may be tested with VER-14 against the paper tape record of the program. If no problem has been discovered in either the memory or the processor, it must be in the circuitry of the I and O-boxes. These may be tested using TEST-14 and a special box tester fixture. To perform this test, the field wires are first removed from the O-boxes.

If a PDP-8 is not available for testing the PDP-14, the central processor may be maintained by using the detailed maintenance manuals supplied with the PDP-14, or by module swapping using the spare parts kit which can be purchased separately.

The maintenance procedure described above may be performed by the end user or by the wide network of well trained DEC Field Service Specialists. Service contracts beyond the normal warranty for the PDP-14 are available.

PDP-14/L

The PDP-14/L has all the features and advantages of the PDP-14 but is a smaller version, limited in expandability. The PDP-14/L can be expanded only to 64 inputs and 64 outputs (or 128 inputs only). Memory expansion is limited to 1,024 words. The 14/L is programmed in the same manner as the PDP-14 with identical software and diagnostics. In fact, they are so similar that their control units are interchangeable.



Available Literature and Documentation on the PDP-14 Programmable Controller

PDP-14 Solid State Controller—descriptive brochure

PDP-14/L Solid State Controller—descriptive brochure

Digital Control Handbook

PDP-14/PDP-14/L Price Summary

*Application Note #1—step-by-step procedure to develop a PDP-14 program

Application Note #2—(see Engineering Note #9)

Application Note #3—using the PDP-14 as a computer interface for monitoring

Application Note #4—SET-14 Symbolic Equation Translator

*Engineering Note #1—use of SIM-14 in a PDP-14/PDP-8 system

Engineering Note #2—connecting a PDP-14 to a PDP-8 family computer

Engineering Note #3—K614 Output Drive fuse data

Engineering Note #4—PDP-14 Severe Environment Kit

Engineering Note #5—PDP-8 bus expander for multiple PDP-14 interface

Engineering Note #6—the BF14M storage module and its use in the PDP-14

Engineering Note #7—noise immunity

Engineering Note #8—accessory box component and uses

Engineering Note #9—counting and shift register functions.

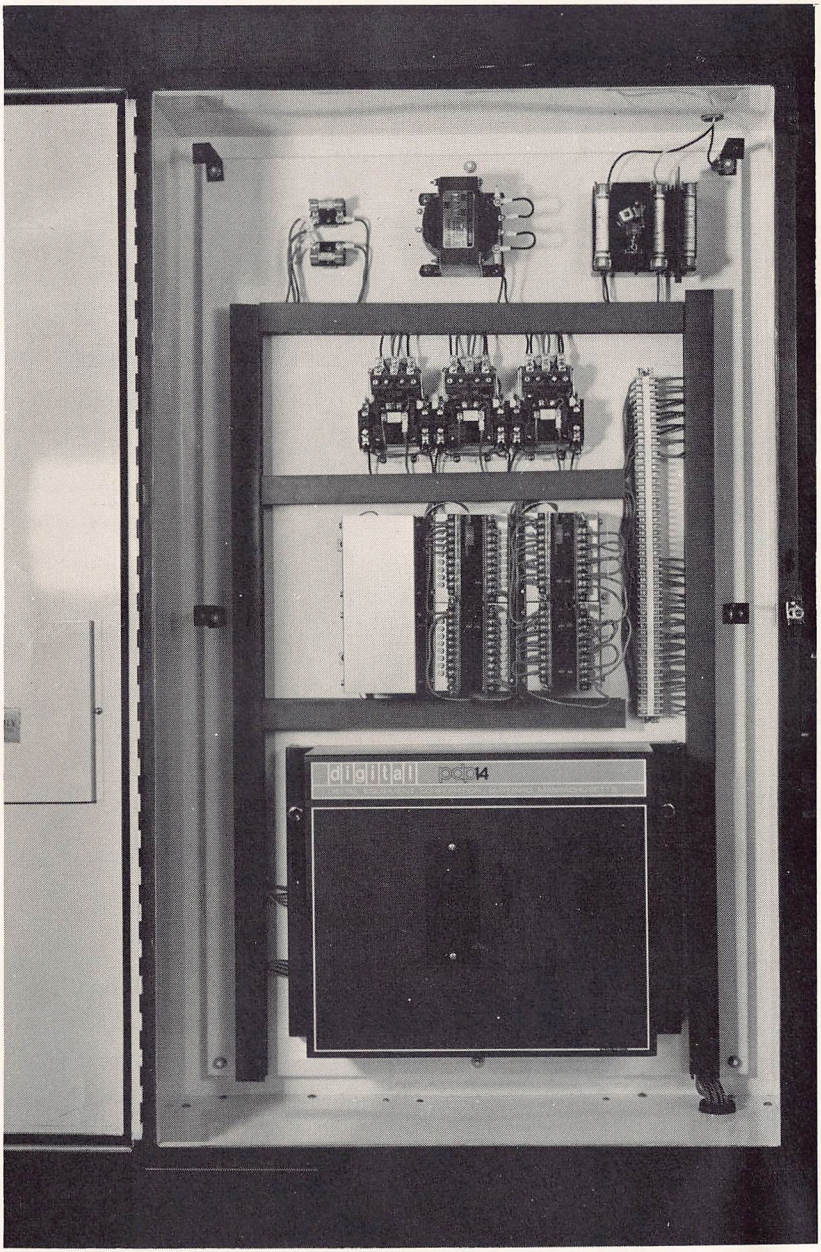
PDP-14 Software Reference Card

**PDP-14 User's Manual

**PDP-14 Maintenance Manual
Vol. I—theory of operation and maintenance
Vol. II—contains circuit schematics

Literature in foreign languages:
Control Handbook—German and Italian
Logic Handbook—German and French
PDP-14 brochure—German, French and Italian
PDP-14/L brochure—French

*periodic additions made to these series
**available upon purchase of equipment



PDP-14 Solid State Industrial Control System (in NEMA enclosure)

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