

PDP-1 COMPUTER
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PDP-21

A MICROTAPPE SYSTEM FOR A TIME-SHARED PDP-1

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The microtape system described in this note is intended to provide users of a PDP-1 time-shared computer with a convenient and responsive program file system suited to informal operation such as the student and research use of the M.I.T. Electrical Engineering Department installation.

The system consists of a control unit and up to four dual tape transport units. Each unit will hold about 128k words in 1000g blocks of 400g words length. Additional information on microtape specifications, mark track coding, and application can be found in the excellent paper by Haufman*.

In typical operation a user will have one or perhaps two microtape units assigned to him when he logs on the computer. On one unit he might mount a tape containing a library of his programs. The other might be used as scratch memory, data, or further programs. The user's program communicates with the microtape units through the following commands interpreted by the time-sharing executive system via instructions trap(s).

- | | |
|----------------|---|
| 1. select (u) | select unit number <u>u</u> (translated) |
| 2. read (n, l) | read block <u>n</u> from selected unit into 400 words starting at location <u>l</u> in user's program |

*Leonard Haufman, 1963 DECUS Proceedings, pp. 221-248, Digital Equipment Corporation, Maynard, Massachusetts.

3. write (n, 1) 1 write 400 words starting at location 1 in user's program on block n of selected unit

The select, read and write commands serve only to communicate instructions to the executive,--they require little time for execution and will not cause dismissal until the executive micro-tape command queue is filled.

4. wait: The user's program is dismissed until all previously entered microtape read and write commands have been completed.
5. act: Execution of previously entered macro tape read and write commands is begun, and the user's program is permitted to continue. The user's program will be interrupted (new break mode) when all commands have been completed.

The executive routine may execute the commands in any logically consistent order so as to minimize tape twiddling.

The executive routine uses the set of iot instructions defined in the following paragraphs to control the microtape system in response to commands from user's programs. The configuration of the system is shown in Figure 1. Information is transmitted between the transports and memory through a high-speed data channel interface in units of a 400-word block. The system includes mark track scanning logic for each transport so that block searching may proceed concurrently on all units without the necessity of elaborate time accounting in the executive routine. Each scanner detects block marks and end marks on its associated transport, and signals the executive by a block mark interrupt and associated status information as noted later.

An 18-bit check sum ring adder is included to automatically record correct forward and reverse check sums, and to verify the sum during reading. The block format is identical to that used for 400-data word blocks in the DEC 550 microtape control unit. The channel address register is an up/down counter so that reading or writing can be done in reverse motion as well as forward.

Microtape Instructions

Note: In out wait does not occur for any of these instructions.

A. Select instructions

<select>

Select microtape unit according to bits 3, 4, 5 of IO. The control enters select busy status for 34 millisecc. following the last <select> instruction executed. The unit remains selected until another <select> instruction is executed. A <select> instruction does not alter tape motion previously established on any unit.

B. Motion control instructions - These instructions apply to the selected unit and may be given at any time following the <select> instruction.

1. direction control

<forward>

Set selected unit for forward motion

<reverse>

Set selected unit for reverse motion

2. run control

<start>

Set selected unit running

<stop>

stop selected unit

These above motion control instructions may be used in any order - the last direction control and the last run control

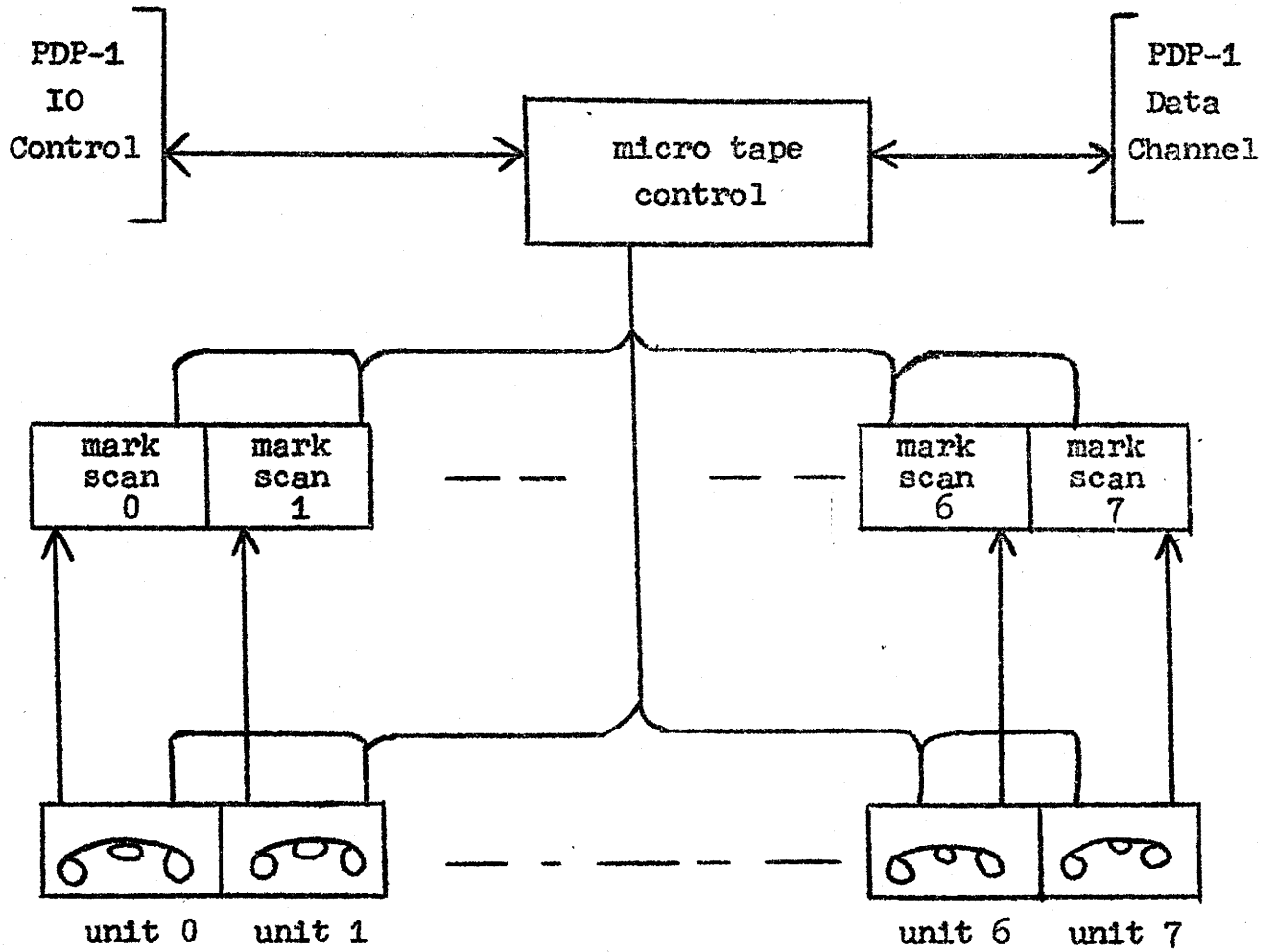


Figure 1. Microtape system configuration.

instructions issued determine the motion finally established. Following a motion control instruction the microtape control will enter motion busy status as soon as it is no longer in select busy status. It will remain in motion busy status until 34 millisecc. after the last motion control instruction issued. The motion control instructions initiate a motion change delay associated with the selected unit: that is used to disable reading while tape speed is low or reversal is in progress. A delay of 150 millisecc. is begun when a previously stopped unit is started. A delay of 250 milliseconds occurs when a running unit is switched in direction of motion.

C. Synchronising instruction

<wait>

This instruction results in a function done interrupt as soon as the control is neither in select busy or motion busy status.

D. Data transfer instructions

<read>

Read the next block encountered on the selected unit in its present direction of motion into core memory start at the address contained in IO. Search for the block mark starts as soon as motion change delay is off and control is not select busy. Search time is from 300 micro sec. to 56 millisecc. The block number is placed in the block number register when the block mark is sensed, and a function done interrupt occurs. Data transfer takes 56 millisecc. after the block mark is found. A second function done interrupt occurs when the data transfer is finished. A new <read>, <write> or <search> instruction can be given following the second interrupt and catch the immediately following block.

Errors (MTE, SCK, CHE) during reading cause a function done interrupt as soon as they are detected. The status indication differentiates the sources.

<write>

Write the information in core memory based at the address given in the IO as the next block on the selected unit in its present direction of motion. Search for block mark, and timing are the same as for <read>. Errors (MTE, CHE) during writing cause a function done interrupt as soon as the error is detected. The status indication differentiates the sources.

<search>

Search for a block mark on the selected unit starts in the present direction of motion as soon as the motion change delay is off. When a block mark is recognized, the block number is placed in the block number register and a function done interrupt occurs. Search time ranges from 300 micro sec. to 56 milisec. <read> or <write> following a successful search function done interrupt will operate on the following block.

<blk number>

Place the contents of the block number register in bits 6-17 of the IO. The block number register is loaded only at block mark recognition following a <read>, <write> or <search> instruction.

E. Block mark interrupt

When a block mark is recognized on any transport in motion, the corresponding one of a set of eight block mark flags is set, and a block mark interrupt is generated. The flag setting and interrupt also occur when the corresponding unit first runs into the end zone of its tape.

<unit number>

The three-bit binary encoding of the lowest numbered unit with its block mark flag on is placed in bits 3, 4, 5 of the IO, and the flag is reset. Bit zero of the IO is set to one if this unit has entered the end zone of its tape.

F. Status indication

<status>

Place status bits associated with the selected unit in IO bits 8-17, according to the following schedule.

| <u>status code</u> | <u>name</u> | <u>bit of IO</u> |
|--------------------|------------------|------------------|
| * RDY | unit ready | 8 |
| * WOK | write permit | 9 |
| * REV | reverse | 10 |
| * RUN | running | 11 |
| * EOT | end of tape | 12 |
| o MTE | mark track error | 13 |
| o SCK | sum check | 14 |
| o CHE | channel error | 15 |
| o TOK | data transfer OK | 16 |
| o EMF | block mark found | 17 |

* reflect the current status of the selected unit

o reset by <read> <write> and <search> at beginning of block mark search - will cause function complete interrupt when turned on after one of these instructions.

G. Instruction coding

iot xx01

| | MB-8 | |
|-----|---------|--------------|
| | 0 | 1 |
| 000 | stop | wait |
| 001 | start | block number |
| 010 | forward | status |
| 011 | reverse | unit number |

MB<9, 10, 11>

| | | |
|-----|--------|-----|
| 100 | select | --- |
| 101 | search | --- |
| 110 | read | --- |
| 111 | write | --- |

stop iot 0001
start iot 0101
forward iot 0201
reverse iot 0301
select iot 0401
search iot 0501
read iot 0601
write iot 0701
wait iot 1001
block iot 1101
status iot 1201
unit iot 1301