

This drawing and specifications, herein, are the property of Digital Equipment Corporation and are not to be reproduced or copied or used in whole or in part without the written permission of Digital Equipment Corporation.

PDP-K TECHNICAL MEMORANDUM # 1

TITLE: Microprogramming Investigation Proposal

AUTHOR(S): Ad van de Goor

DATE: November 26, 1969

INDEX KEYS: Microprogramming  
Read Only Memory  
Instruction Set  
Compatability  
Interpreter

DISTRIBUTION KEYS: Stan Olsen  
John Jones  
Jerry Butler  
Bob McInnis  
Jim Bell  
C. Kaman  
Don Vonada  
C. Gordon Bell  
Bob Gray  
Dan Brevik  
Fritz Aumann  
Len Halio  
Phil Landry

0.0 INTRODUCTION

This memo contains a proposal to investigate microprogramming techniques with regard to a possible implementation on the PDP-K. The initial investigation is intended to be of a short duration (a few man months). It aims at the design of a microprogram interpreter on the PDP-10 to interpret PDP-10 code.

## 1.0 DEFINITIONS

### Microprogram:

A program resident in fast memory (most often not the main memory) which decodes the instructions from the main memory into a set directly executable by the hardware. With other words the microprogram maps the machine language instruction set into a set directly executable by the hardware.

### Microprogramming:

The use of the technique of mapping one instruction set into another under control of a microprogram.

### Read Only Memory:

A memory (implemented in some technology) which is difficult or impossible to change. It is used very often to contain microprograms.

## 2.0 MICROPROGRAMMING USE

From research done so far, it has become quite clear that microprogramming is a very powerful tool for designing machines. Several of DEC's competitors have recognized this and use it to their benefit.

In the design of a new processor, which does not necessarily have to be program compatible with an existing model, the problem of choosing the "right" instruction set is a severe one. Most often compromises have to be made between conflicting issues like cost, hardware complexity, speed, expandability, ease of machine language programming, ease of implementing system software, and general purposeness.

Microprogramming solves some of those problems and has other attractive properties.

- 2.1 Microprogramming facilitates the design process of a new machine to the extent that no fixed, high level instruction set has to be chosen, the usefulness of which cannot be judged completely at the implementation stage.
- 2.2 Available talent in the company is used in a more optional way. The Engineer can work on the gate and register transfer level, exactly there where his talents are. The problem of selecting the instruction set is moved to the Programmer where it belongs.
- 2.3 Because of the flexibility of a microprogrammed machine, it can be made to behave like existing models saving the company and the customers expense of reprogramming the software and/or allowing a gradual adaptation to the new system.
- 2.4 Options like floating point arithmetic etc., can be implemented cheaply as well as dedicated control functions which can lead to much cheaper I/O control units.

- 2.5 Special instructions can be provided to handle certain classes of problems more efficient (e.g., compiling). Current literature shows cases where this gave improvements in speed of almost an order of magnitude above programs written in the standard machine language. This easily compensates for the inherently slower structure of a microprogrammed machine.

### 3.0 POSSIBLE PDP-K CONFIGURATIONS

This is just a conjecture to where microprogramming could lead when found to be satisfactory. A family of machines could be designed having 18 or 36 bit word lengths being program compatible throughout the family and with the PDP-10 and/or PDP-11 and/or PDP-15 and possibly with some machines of competitors. This would not only be nice from a Marketing point of view, such a family would also have a good change for a longer life because it is more adaptable to new technologies and architecture.

#### 4.0 MICROPROGRAMMING INVESTIGATION PROPOSAL

As of to date the company has been exposed to microprogramming only once in the design of the PDP-9. The power of this technique was used there only to a limited extent. In order to gain some experience with microprogramming and its power and to allow for some experimentation it is suggested to implement a microprogram interpreter on the PDP-10. The initial plan is to build one and get it going, not over emphasizing issues like efficiency etc. for the first time around. Because of the experience to be gained from PDP-10 coding and the consistent PDP-10 instruction set it is suggested initially, to make a microprogram for the PDP-10 only to test the interpreter. The effort for doing the above is estimated to be a few man months.