PDP-11/40 Technical Memorandum # 11

Title: Data Format Conventions for PDP-11/40

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Index Keys: Data Formats
Numbering Sequences

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0.0 Abstract

This memo is concerned with certain data formats being proposed for the PDP-11/40. The proposed formats have the property of being compatible with what is considered standard in the computer industry and people's intuition. It is, however, not compatible with some PDP-11/20 software conventions.

The reasons for the proposed PDP-11/40 formats are given together with guidelines for future decisions.

1.0 Adopted PDP-11/20 Conventions

Many conventions concerning the numbering of bits in a word, data formats, etc. have been adopted for the PDP-11/20. Some of these are related to the hardware implementation and are, therefore, fixed for the PDP-11 family. Other conventions made concern themselves with data formats not yet supported by hardware. These, of course, could be subject to modifications.

1.1 Numbering Bits in a Word

In the PDP-11/20, bits are numbered in such a way that the most significant bit gets the highest number and the least significant bit the lowest number (i.e., Ø).

It has to be noted that none of the DEC machines has a numbering system like the PDP-11. Table 1 below shows how some other manufacturers have numbered the bits in their words.

Table 1
Numbering of Bits in a Word

Most Significant Bit = Number 0	Least Significant Bit = Number 0
PDP-8	Burroughs 6500/7500
PDP-9/15	
PDP-10/10I	
SYSTEM 86	Univac 1108
SIGMA 5/7	
SPECTRA 70 Series	CPI/2000
IBM 180	
IBM 360 Series	SPC - 16
SDS 940	
ATLAS	HP 2114
SIEMENS 300	
META 4	
B5500	
GE - PAC·30	
EAI - 640	
SPIRAS - 65	
NOVA	
RC77	
GE635	
HONEYWELL 516	

1.2 Numbering of Bytes in a Word

The PDP-11/20 convention is to number bytes from right to left as shown below. Table 2 shows how some other computer manufacturers number bytes.

Byte 1	Byte 0
3	2
5	4

Table 2
Numbering of Bytes

Start Counting from Left	Start Counting from Right
GE635 BURROUGHS 6500/7500 SYSTEM 86 SIGMA 5/7 PDP-10 SPECTRA 70 Series IBM 360 Series	NOVA

Note: Because the NOVA is not quite a byte-oriented machine, their numbering system is not so apparent.

1.3 Ordering Multiple Word Integer Numbers

The PDP-11/20 convention for ordering multiple word integer numbers in memory is shown below. The address of the number is determined by the position of the low bits, which are stored first. Table 3 shows how some other computer manufacturers order their multiple length numbers.

low bits	memory location n
high bits	memory location n+2

Double Length Number

Table 3
Ordering of Multiple Word Integer Numbers

Highest Bits First	Lowest Bits First
UNIVAC 1108 SPECTRA 70 Series IBM 360 Series PDP-10/10I SYSTEM 86 SIGMA 5/7 NOVA EAI 640 etc.	Nobody

1.4 Ordering Floating Point Numbers

The PDP-11/20 convention for ordering floating point numbers is like that for ordering multiple word integer numbers and is shown below. The address of the number is determined by the position of the low bits of the mantissa, i.e., location n. Table 4 shows how some other computer manufacturers order their floating point numbers.

Floating Point Number

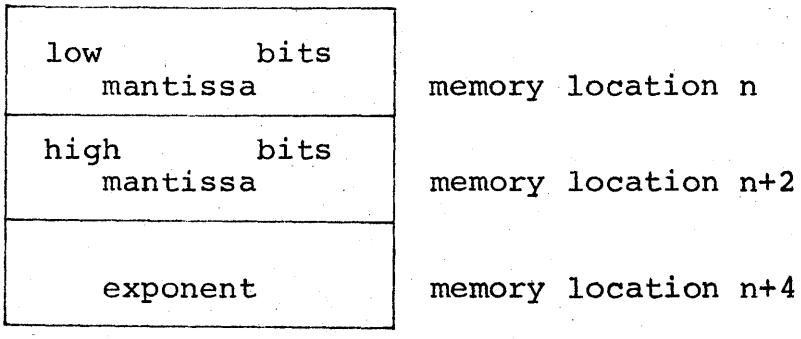


Table 4
Ordering of Floating Point Numbers

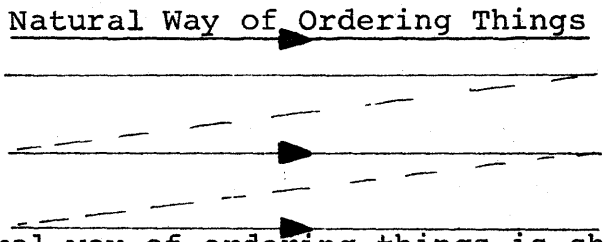
Order: Exponent; high, low mantissa	Order: low, high mantissa; exponent
UNIVAC 1108 BURROUGHS 5500/6500/7500 SPECTRA 70 Series IBM 360 Series SIGMA 5/7 SYSTEM 86 PDP-10 etc.	Nobody

2.0 Conventional Way of Ordering

A small test was given at DEC to a group of people consisting of secretaries, engineers, and programmers (also some housewives were included). They were asked to put digits and letters in squares according to a method they considered natural. The overwhelming majority obeyed the following rule:

1. First, numbering occurred in increasing order from left to right.

2. When at the end of a line the next lower line was started, i.e., from top to bottom.



The natural way of ordering things is shown above. People write letters this way, TV rasters are written this way, elements in matrixes A[i, j] are addressed this way, etc. It is not surprising that, except for the PDP-11/20, nearly all computer manufacturers obey this rule very closely.

3.0 Suggested PDP-11/40 Conventions

Two PDP-11/40 conventions should not be changed because of hardware compatibility reasons. These are:

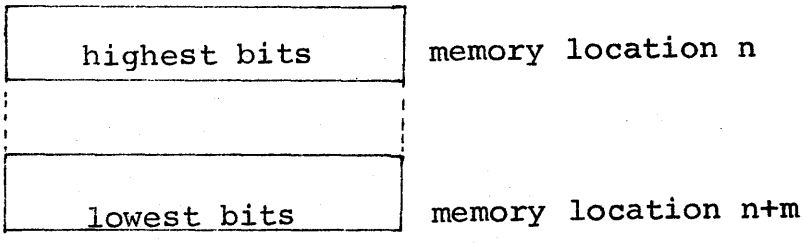
1. The numbering of bits in a word.

2. The numbering of bytes in a word.

3.1 Multiple Word Integers

It is suggested that these are stored as shown below.

MULTIPLE WORD INTEGER



The address of the number is determined by the position of the highest bits. The highest (most significant) bits are stored first, the lowest (least significant bits) are stored last (i.e., in the highest numbered location).

3.2 Ordering Floating Point Numbers

Floating point numbers will be ordered the traditional, natural way. Because appropriate formats are not selected yet, only the sequence can be indicated: exponent, high order bits of mantissa, low order bits of mantissa. The sign of the mantissa probably precedes the exponent.

A scanning of the listing of the floating point package, as currently exist for the PDP-11/20 shows:

1. Changes to adopt the proposed convention are minimal.

2. Routines dealing with multiple word integer numbers use the proposed convention already internally, all that needs to be changed is the external representation.

Test instructions are cheaper and easier to implement using the proposed formats

The proposed formats obey people's intuition and are compatible with the rest of the world.