PROJECT STRETCH   October 30, 1956
DELTA COMPUTER MEMO NO. 14

Subject: Data Word Formats

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Data word formats are defined herein assuming a machine word of 64 bits,
numbered from left to right and from 00 to 63.   There are five binary vari-
ables that affect data word format.   These are fixed vs. variable length,
fixed vs. floating radix point, radix 2 vs. radix 10 arithmetic, signed vs.
unsigned arithmetic, and (for radix 10) four bit vs. six bit byte size for
each digit.   These generate 32 possible cases which might require dif-
ferent data formats.   Because all the combinations cannot occur or are not
all desirable, some exclusions may be made at once.   Variable length
floating-point operations are excluded.   Six bit bytes for binary arithmetic
are not distinguished from four bit bytes, so they are excluded.   Unsigned
floating point operations are excluded.   These exclusions leave fifteen for-
mats that must be investigated.   These are shown in Figure 1.

Signs

All signed data includes a four-bit sign byte which is located at the right end
of the word.   Bit 63 is left free for programmer use.   Bit 62 is used for ex-
ponent sign in floating point and is left free in fixed point.   All zero exponents
are tagged with a positive exponent sign.   Bit 61 is used for a zero mantissa
indication in both fixed and floating point.   Zero is represented by a 0 in this
bit, non-zero is indicated by a 1.   Bit 60 represents the sign of the number.
For both numbers and exponents, 0 indicates positive sign, 1 indicates nega-
tive sign.   The collating sequence for both numbers and exponents is as
follows:

$$+ N Z > + Z \gtrless - Z > - N Z.$$

However, floating point numbers are compared with exponent dominant over
mantissa, so that if two unnormalized floating point numbers are compared,
they may give a false indication.

Delta Computer Formats

All of the formats shown in Figure 1 are used in the Delta Computer.   Format
00000 is a fixed-length, fixed point binary format.   Since it is contemplated to
provide only a 48-bit adder in the Sigma computer, the Delta must operate
with words of sign and 48 bits.   Because the circuitry for the Delta is serial,
the alternative format of a sign and 60 bits is also a possible mode for the
Delta.   The programmer can easily use this mode by ordinary variable-length
addressing.

Correction:

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The collating sequence should read:

$$+NZ > +Z = -Z > -NZ$$

Format 00010 is the logical word, with 64 undesignated bits.

Formats 00100 to 00111 cover four and six-bit decimal fixed point words. It is likely that 00111 is of limited utility, since unsigned alphanumeric data will probably occur predominantly in variable length fields. This type of format will be considered permitted until further notice, however.

Formats 01000 to 01101 are for floating point numbers. The first is for binary, the second for 4-bit decimal bytes, and the third for 6-bit decimal bytes. The six-bit floating decimal operation appears to be of little extra cost, and the reduced editing requirements might well make the it the operation mode of choice by programmers on all brief problems.

The rest of the formats are for variable length operation. In this definition, it is assumed that no variable length field can be more than 128 bits long and that each field must come out even in terms of bytes, after the sign byte has been processed. Thus, only formats 10000 and 10010 are distinct, the rest are special cases of them, and will be handled as such in the computer.
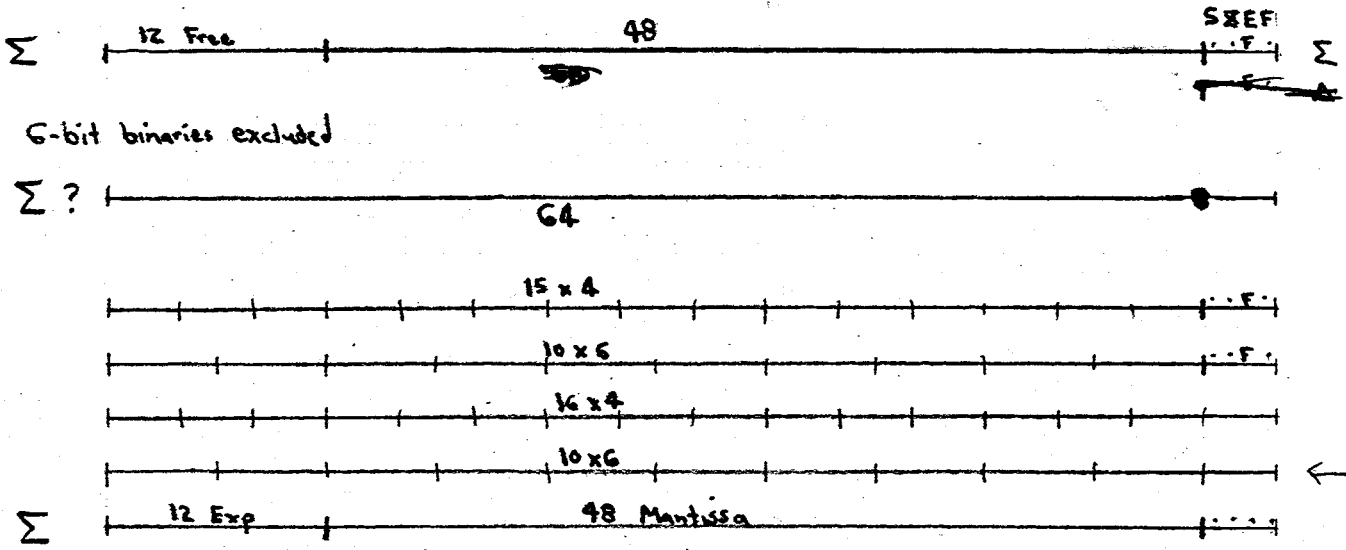
Sigma Computer Formats

The Sigma computer is to operate with only three of these fifteen formats, the first of 00000 a 48-bit fixed binary word; 00010, a 64-bit logical word which would not be processed by the adder; and 01000, a 12-48 bit floating point word. These are indicated in Figure 1 by the sigma beside each of the three.

Δ Formats

0	0	0	0	0	Σ 12 Free 48 S8EF Σ
0	0	0	0	+	All 6-bit binaries excluded
0	0	0	1	0	Σ ? 64 •
0	0	0	1	+	
0	0	1	0	0	15 × 4 ...F...
0	0	1	0	1	10 × 6 ...F...
0	0	1	1	0	16 × 4
0	0	1	1	1	10 × 6 ← ?
0	1	0	0	0	Σ 12 Exp 48 Mantissa ......
0	1	0	0	+	
0	1	0	1	0	All unsigned floating excluded
0	1	0	1	+	
0	1	1	0	0	3 × 4 12 × 4
0	1	1	0	1	2 × 6 9 × 6
0	1	1	1	0	
0	1	1	1	+	
1	0	0	0	0	n ≡ 4 mod b ...F...
1	0	0	0	●	
1	0	0	1	0	n ≡ 0 mod b
1	0	0	1	+	
1	0	1	0	0	n ≡ 0 mod 4 ...F...
1	0	1	0	1	n ≡ 4 mod 6 ...F...
1	0	1	1	0	n ≡ 0 mod 4
1	0	1	1	1	n ≡ 0 mod 6
●					excluded all variable length floating
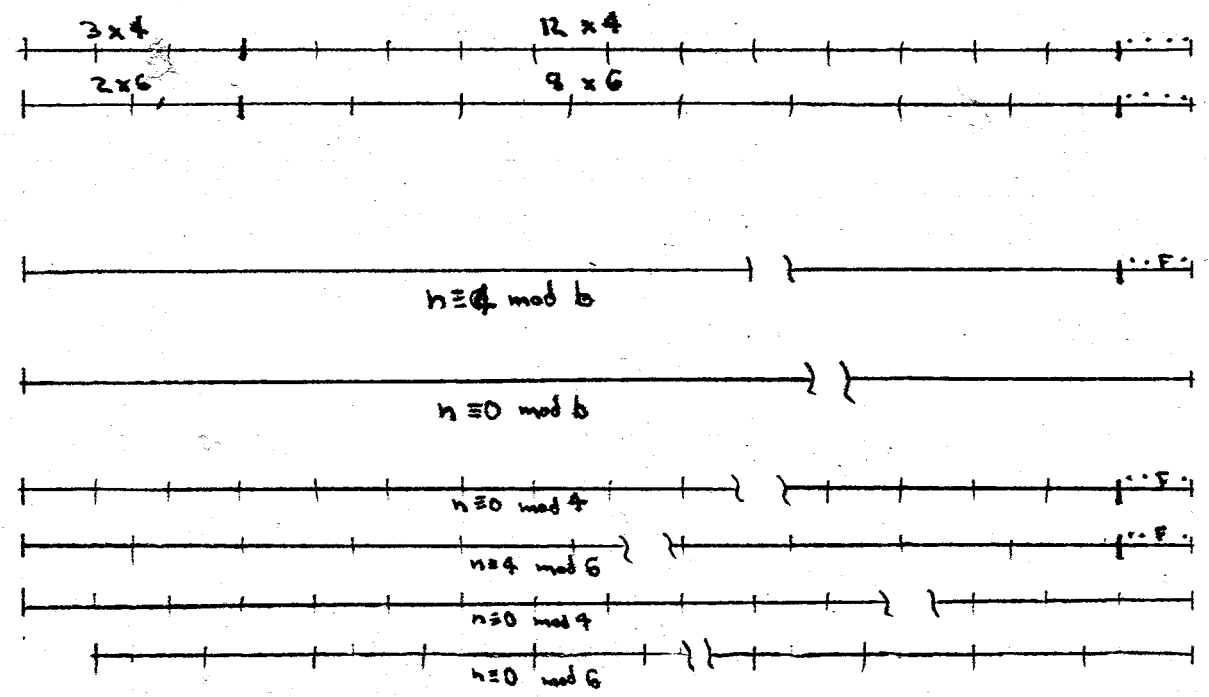
Floating Point (left margin label)

Variable Length (left margin label)

n = total bits
n < 128 on all v.l. op.
b = byte size

} Formats physically and conceptually subcases of 10 000 and 10 010 with different arith control

Fig 1. Data Word Formats