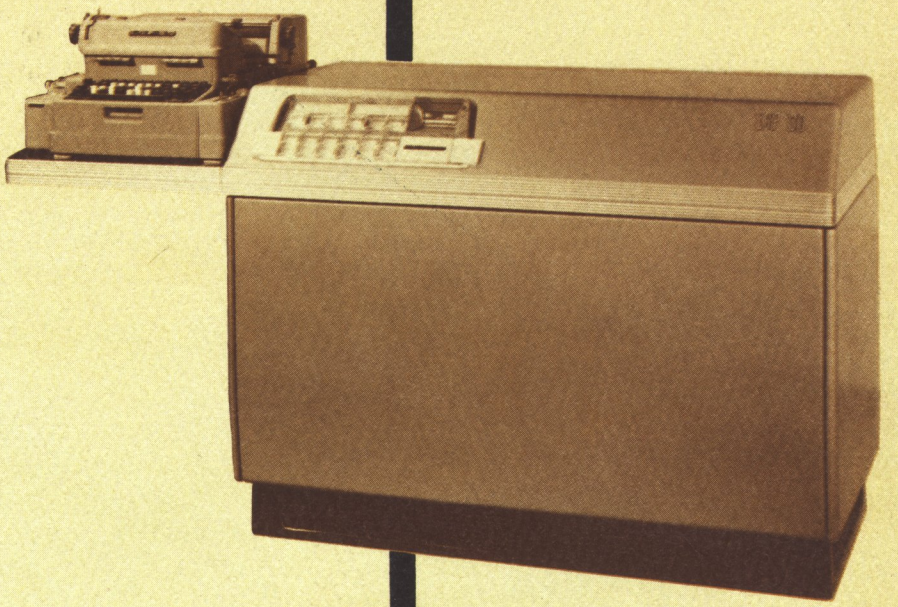
LGP30

H1-24.3



FLOATING POINT INTERPRETIVE SYSTEM 4

programming manual

GENERAL PRECISION, INC.
Commercial Computer Division

FLOATING POINT INTERPRETIVE SYSTEM 4

EXTENDED RANGE-DOUBLE PRECISION

for the **LGP 30** General Precision Electronic Computer

PROGRAM NO. H1-24.3

REVISION NOTICE

This description combines and obsoletes all previous descriptions of the following programs:

Floating Point Interpretive System 4, program H1-24.3
Trace and Memory Print 7, program K1-23.6
Floating Point Functions

FLOATING POINT INTERPRETIVE SYSTEM 4

SECTION I FUNCTION

"Floating Point Interpretive System 4," program H1-24.3, enables the LGP-30 to perform arithmetic operations on numbers written in floating point format and containing up to 16 decimal digits. In addition, the system provides for the evaluation of several non-linear functions. A trace program is included for the programmer's convenience in checking out double precision programs.

This publication contains a description of the following features:

SECTION II INTERNAL WORD FORMAT

Data are represented within this system by three successive memory locations, two for the fraction and a third for the binary exponent. The most significant bit of the fraction is bit position 2. The junction between the first and second words occurs between bit positions 30 and 31. There is a q difference of 28 between the first and second word (bit position 31 in the first word appears as bit position 3 in the second word). The fraction words will be unaltered by extraction with the following masks:

wwwwwwwq 1wwwwwwq.

The binary exponent is carried in the third word at q = 29. Except during input and output, the binary exponent (E) must satisfy the inequality

$$+536,870,912 > E > -536,870,912.$$

The interpretive system's "accumulator" consists of locations L_o + 1243, L_o + 1245, L_o + 1247 with L_o the location of the initial instruction of the program. In this discussion the notation "accumulator" shall refer to these three programmed locations rather than to the actual machine Accumulator, unless otherwise stated.

SECTION III INPUT-OUTPUT FORMAT

A. STANDARD FORMAT

The standard data format for input-output is

XXXXXXXX'XXXXXXXX'±EE±'

XXXXXXXX'XXXXXXXX' is an integer representing the significant digits of the input word. The sign preceding EE is the sign of the integer. EE is the exponent of ten by which the integer must be multiplied to equal the value represented. The final sign is the sign of the exponent. Normally, EE will satisfy the inequality

$$00 < EE < 100$$

However, the first digit of the exponent may be a hexadecimal digit. Thus, J8 represents an exponent of 128.

B. OUTPUT

On output data will always appear in the standard format, followed by a tab.

C. INPUT

During input, data may vary from the standard format in that only significant digits need be entered. However, all stop codes (') or start signals and all characters of ±EE±' must be entered.

If an I0000 instruction is used for input, the location where data loading is to begin must be specified as the first word of input. If an IXXXX instruction is used, XXXX is the location where loading will begin.

Data will be loaded sequentially until either a g' or an f' is entered. g' indicates the end of a group of data, and a new loading address must be entered for the next group of data. f' indicates the final word of data has been entered. The routine will then execute the instruction following the I instruction.

INPUT-OUTPUT FORMAT

INPUT (Cont.)

Example: Using an I0000 instruction to enter this data,

1,234,567,812,345,678	in 5234
.001234	in 5237
-100	in 5300
7.0×10^{155}	in 5303

requires the following format:

```
5234'12345678'12345678'+00+'
'1234'+06-'g'
5300''1'-02+'
'7'+w5+'f'
```

SECTION IV FLOATING POINT FUNCTIONS

The Floating Point Functions program is loaded by means of the following code words (L_o is the initial location of the interpretive system):

```
;000 (Lo + 1400)
/000 (Lo)
```

When the program is properly loaded, the following functions may be evaluated in double precision, floating point format: Square Root; Sine, Cosine, Arctangent (in radians or degrees); Natural or Common Logarithm; and, Natural or Common Antilogarithm. This portion of the system also provides for Reciprocal Division.

SECTION V TRACE AND MEMORY PRINT 7

A trace routine is included with the Floating Point Functions portion of the interpretive system. In addition, the trace routine is included on the program tape as a separate program in order that it may be used even when the Functions portion is not in memory. To load the trace program—separately from the Functions—the following code words are required:

```
;000 (Lo + 1400)
/000 (Lo)
```

(Again, L_o is the initial location of the interpretive system.)

TRACE AND MEMORY PRINT 7 (Cont.)

The trace program is activated when the TRANSFER CONTROL switch is depressed. For each floating point instruction executed during a trace, the location of the instruction, the instruction itself, and the contents of the accumulator are printed. The only exception is the instruction E0000 (Exit from system) which does not result in a printout.

SECTION VI FLOATING POINT INSTRUCTIONS

In the following discussion, the address XXXX represents the 3 consecutive memory locations XXXX, XXXX+1, and XXXX+2, which contain a double precision floating point value; TTSS represents a decimal address (track TT, sector SS) indicating a memory location; and the accumulator mentioned is that of the interpretive system.

A. ARITHMETIC OPERATIONS

Z0000 — Stop
The computer stops. Depress START switch to continue.

BXXXX — Bring
The contents of memory location XXXX replace the contents of the accumulator.

Y0000 — Change
The sign of the contents of the accumulator is changed.

I0000 — Input
Input data; initial location of storage must be specified.

ITTSS — Input
Input data; initial location of storage is TTSS.

DXXXX — Divide
The contents of the accumulator divided by the contents of XXXX replace the contents of the accumulator.

MXXXX — Multiply
The contents of the accumulator multiplied by the contents of XXXX replace the contents of the accumulator.

FLOATING POINT INSTRUCTIONS

ARITHMETIC OPERATIONS (Cont.)

P0000 — Print
Print the contents of the accumulator in standard format. The accumulator remains unaltered.

PXXXX — Print
Print the contents of memory location XXXX in standard format. The accumulator remains unaltered.

E0000 — Exit
Exit from the interpretive system; the following instruction will be executed in machine language. After the execution of an E0000 instruction, the machine Accumulator will contain the first word of the system's accumulator.

UTTSS — Unconditional Transfer
The next instruction to be interpreted is in location TTSS.

TTTSS — Test
The next instruction to be interpreted is in location TTSS if the contents of the accumulator are negative; otherwise the instruction following this Test instruction is executed.

HXXXX — Hold
The contents of the accumulator replace the contents of memory location XXXX. The accumulator remains unaltered.

CXXXX — Clear
The contents of the accumulator replace the contents of memory location XXXX. The accumulator is set to zero.

AXXXX — Add
The contents of the accumulator plus the contents of memory location XXXX replace the contents of the accumulator.

SXXXX — Subtract
The contents of the accumulator minus the contents of memory location XXXX replace the contents of the accumulator.

FLOATING POINT INSTRUCTIONS (Cont.)

B. INSTRUCTIONS FOR BASIC FUNCTIONS

R0000 — Square Root
The square root of the contents of the accumulator replaces the contents of the accumulator.

RXXXX — Reciprocal Divide
The contents of memory location XXXX divided by the contents of the accumulator replace the contents of the accumulator. The contents of XXXX must be data in standard format.

S0000 — Sine
The sine of the contents of the accumulator replaces the contents of the accumulator. The accumulator must be in degrees.

S0001 — Sine
The sine of the contents of the accumulator replaces the contents of the accumulator. The accumulator must be in radian measure.

C0000 — Cosine
The cosine of the contents of the accumulator replaces the contents of the accumulator. The accumulator must be in degrees.

C0001 — Cosine
The cosine of the contents of the accumulator replaces the contents of the accumulator. The accumulator must be in radian measure.

A0000 — Arctangent
The arctangent of the contents of the accumulator replaces the contents of the accumulator. The result, Y, is expressed in degrees ($-90 \leq Y \leq 90$).

A0001 — Arctangent
The arctangent of the contents of the accumulator replaces the contents of the accumulator. The result, Y, is expressed in radians ($-\pi/2 \leq Y \leq \pi/2$).

FLOATING POINT INSTRUCTIONS

INSTRUCTIONS FOR BASIC FUNCTIONS (Cont.)

N0000 — Natural Logarithm
The natural logarithm of the contents of the accumulator replaces the contents of the accumulator.

N0010 — Common Logarithm
The common logarithm of the contents of the accumulator replaces the contents of the accumulator.

H0000 — Natural Antilogarithm
The quantity e^X replaces X, the contents of the accumulator.

H0010 — Common Antilogarithm
The quantity 10^X replaces X, the contents of the accumulator.

C. ACCURACY AND RANGE OF FUNCTIONS

The maximum error in all cases is on the order of (1×10^{-16}) or $(10^{-16} \times$ the function), whichever is greater. The approximate ranges of the functions are given in the table below (Z is the maximum number held by the system):

Function	Minimum	Maximum
R0000	0	Z
S0000 - C0000	$-.421 \times 10$	$.421 \times 10$
S0001 - C0001	-2.3×10	2.3×10
A0000 - A0001	-Z	Z
N0000 - N0010	1/Z	Z
H0000	-1.8×10	1.8×10
H0010	$.8 \times 10$	$.8 \times 10$

SECTION VII STORAGE

The complete system requires thirty tracks (1920 words) of memory. The various portions of the system require the following storage:

Floating Point Interpretive System 4	14 tracks 22 sectors
Floating Point Functions (including Trace)	15 tracks 42 sectors
Trace and Memory Print 7	56 sectors

If the logarithm and antilogarithm instructions are not to be used, the area after (L_o + 2463) may be used for other purposes.

SECTION VIII ERROR HALT

An error halt will occur at location (L_o + 1058) if the range of an instruction is exceeded or if an attempt is made to execute an illegal operation, such as, the square root or logarithm of a negative number. In the event of an error halt, the contents of the accumulator may have been destroyed.

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