April 22, 1958

FILE MEMO

SUBJECT: Floating Point Multiple Precision Routines

Programs are attached which show the effectiveness of Stretch in doing double and triple precision arithmetic. (This gives the equivalent of 28-29 or 43-44 decimal digits.)

As was expected, the double precision routines were extremely straightforward and easy to program since the double precision accumulator eliminates most coupling effects between high and low order portions which ordinarily must be programmed.

The triple precision programs were written to see what was required when the coupling effects had to be considered. Even in these cases the programs are fairly simple compared to other computers in which this type of routine has to be interpretively coded in fixed point and then converted back to floating point. The operation, Store With Borrow, was originally conceived as a requirement for multiple precision addition to afford coupling facility but it was found unnecessary with the present configuration and it is recommended that it be dropped.

Note that no attempt was made to guarantee the accuracy of the lowest order bits. To do this requires doing arithmetic of almost the next higher precision. For example, to guarantee the low order bit in single precision requires almost the work of double precision.

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Double Precision

APPLICATION: ADD, MULTIPLY, and DIVIDE PAGE: 1 DATE-INITIALS: 4/22/58 TWS

LOCATION	CL	OP	M	CI	ADDRESS	X	I	ADDRESS PX IL E OF	X	REMARKS
ADD										These routines assume one operand in the accumulator, the other is in storage (K,L), and the result is left in the accumulator.
d+0	N	AD	S		L					
d+1	N	AD	S		K					
MULTIPLY										
d+0	N	LCHD	S		A register					
d+1	U	SLO	3		A register					
d+2	U	MPYD	S		K					
d+3	N	MPYC	S		L					
d+4	N	MPYC	S		K					
DIVIDE										
d+0	N	DIVD	S		K					
d+1	N	S	S		M register					
d+2	N	MPYD	N		L					
d+3	N	AD	S		R register					
d+4	N	DIVD	S		K					
d+5	N	AD	S		M register					

APPLICATION: Double Precision - ADD, MULTIPLY, and DIVIDE PAGE: 2 DATE-INITIALS: 4/22/58 DWS

LOCATION	CL	OP	M	CI	ADDRESS	X	I	ADDRESS PX L B OF	X	REMARKS
ADD										These routines assume
0+0	U	LD	S		G					operands in storage
1	N	AD	S		L					(E,G) and (K,L) with
2	N	AD	S		F					the result in storage (R,S)
3	N	AD	S		K					
4	U	S	S		R					
5	U	SLO	S		S					
MULTIPLY										
0+0	U	L	S		G					
1	U	MPYD	S		K					
2	U	LCMD	S		F					
3	N	MPYC	S		L					
4	N	MPYC	S		K					
5	U	S	S		R					
6	U	SLO	S		S					
DIVIDE	U	LD	S		F					
	N	AD	S		G					
	N	DIVD	S		K					
	N	S	S		R					
	N	MPYD	N		L					
	N	AD	S		Register					
	N	DIVD	S		K					
	N	AD	S		R					
	U	S	S		R					
	U	SLO	S		S					

APPLICATION: Triple Precision ADD PAGE: 3 DATE-INITIALS: 4/22/58 TWS

LOCATION	CL	OP	M	CI	ADDRESS	X	J	ADDRESS PX	L	B	OF	X	REMARKS
d+0	U	L	PAB		F								The operands are (F,G,H) and (K,L,M). The result replaces (F,G,H)
1	U	A	NAB		K								
2		BIN	EL	M	d+4								
3	E	SWP	F		F			K				3	
4		BIN	NL	PSH	d+24								
5	U	LD	S		F								
6	N	AD	S		K								
7		BIN	NL	Z	d+27								
8	U	S	S		F								
9	U	SLO	S		K								
10	U	LD	S		M								
11	N	AD	S		H								
12	N	AD	S		L								
13	N	AD	S		G								
14	N	AD	S		K								
15	U	SLO	S		H								
16	U	AD	N		H								
17	N	AD	S		F								
18	N	S	S		F								
19	U	SLO	S		G								
20	U	LD	S		G								
21	U	AD	S		H								
22	U	S	S		G								
23	U	SLO	S		H end of routine								
24	U	LD	S		K								
25	U	SLO	S		K								
26		B			d+11								
27	U	SLO	S		F								
28		B			9+9								

APPLICATION: Triple Precision MULTIPLY PAGE: 4 DATE-INITIALS: 4/22/58 DWS

LOCATION	CL	OP	M	CI	ADDRESS	X	J	ADDRESS PX	ADDRESS L	ADDRESS B	ADDRESS OF	X	REMARKS
a+0	U	L	S		F								The operands are (F,G,H) and (K,L,M). The result replaces (F,G,H)
1	U	LCMD	S		F								
2	N	MPYD	S		K								
3	N	S	S		F								
4	U	SLO	S		Register								
5	U	L	S		H								
6	U	MPYD	S		K								
7	N	MPYC	S		M								
8	N	MCYC	S		L								
9	U	LCMD	S		G								
10	N	MPYC	S		L								
11	N	MCYC	S		K								
12	N	A-D	S		Register								
13	U	SLO	S		H								
14	U	AD	N		H								
15	N	A-D	S		F								
16	N	S	S		F								
17	U	SLO	S		G								
18	U	LD	S		G								
19	U	AD	S		H								
20	U	S	S		G								
21	U	SLO	S		H								

APPLICATION: Triple Precision DIVIDE PAGE: 5 DATE-INITIALS: 4/22/58 TWS

LOCATION	CL	OP	M	CI	ADDRESS	X	I	ADDRESS PX	L	E	OF	X	REMARKS
q+0	U	LD	S		F								The operands are
1	U	AD	S		G								(F,G,H) and (K,L,M).
2	N	DIVD	S		K								The quotient replaces
3	N	S	S		F								(F,G,H).
4	U	MPYD	N		L								
5	N	AD	S		R register								
6	N	DIVD	S		K								
7	U	S	S		G								
8	U	MPYD	N		L								
9	U	LCMD	N		F								
10	N	MPYC	S		M								
11	N	AD	S		R register								
12	N	DIVD	S		K								
13	N	AD	S		G								
14	U	SLO	S		H								
15	U	AD	N		H								
16	N	AD	N		F								
17	N	S	S		F								
18	U	SLO	S		G								
19	U	LD	S		G								
20	U	AD	S		H								
21	U	S	S		G								
22	U	SLO	S		H								