PRELIMINARY INFORMATION

ON THE

EXECUTION TIME OF THE

1103A FLOATING POINT INSTRUCTIONS

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SUMMARY OF EXECUTION TIMES

		Max.	Min.
Floating add and subtract	$(N \leq 1)$	300 μ sec.	144 μ sec.
$(N) = (u_c) - (v_c)$	$(N \geq 2)$	236	148
Floating multiply		380	162
Floating divide		654	648
Floating polynomial multiply		619	262
Floating inner product		637	280
Floating unpack		52	54
Floating normalize pack		180	144
Normalize exit		20	20

All times given include magnetic core reference time. If (u) is A, subtract 6 μ sec.; if Q, subtract 4 μ sec. All cases are for NE FF set to zero. If NE FF = 1, set K = 0 and subtract 12 μ sec. All cases include rounding. If the full number of normalizing shifts are made (35 for addition and subtraction, 2 for multiplication and division), the mantissa is zero and rounding is omitted. For this case, subtract 14 μ sec.

The following symbols are used in the formulas.

$N = (u_c) - (v_c)$ for operations 64, 65, 66, and 67

$N = (Qu)_c - (v_c)$ for operation 01

$N = (uv)_c - (Q_c)$ for operation 02

N_9 is the sign of this difference (corresponding to S_9 at the

points when $(S) = (u_c) - (v_c)$

or $(S) = (Qu)_c - (v_c)$

or $(S) = (uv)_c - (Q_c)$

K is the number of normalizing shifts (the number of shifts necessary

to put the MSB of the arithmetic result of (u_m) and (v_m) in A_{61} -- maximum

of 35 for addition and subtraction, 2 for multiplication and division).

Floating point add and subtract (FAuv and FSuv)

MP 0 (Unpack (u) sequence)	$7 + 2(u_{35})$	
1 (Unpack (v) sequence)	$7 + 2(v_{35})$	
2 (Initial alignment)	1	$+ 3(N_9)$
3 (Final alignment)	4	$+ 2(N_9) + 2|N|$
5 (NRP sequence)	12	$+ (34 -|N|) + 2K$
6 &7 (Set up NI)	7	

Total (in clock pulses) $38+2(u_{35})+2(v_{35})+5(N_9)+2|N|+(34-|N|)+2K$

Total (in μ sec.) $76+4(u_{35})+4(v_{35})+10(N_9)+4|N|+(68-2|N|)+4K$

	Case I $N=0$			Case II $N=1$	
Max.	Min.		Max.	Min.	
76	76		76	76	
4	0		4	0	
4	0		4	0	
10	0		10	0	
0	0		4	4	
68	68		66	66	
136	0		136	0	
298 μ sec.	144 μ sec.		300 μ sec.	146 μ sec.	

	Case III $N=2$			Case IV $N=34$	
Max.	Min.		Max.	Min.	
76	76		76	76	
4	0		4	0	
4	0		4	0	
10	0		10	0	
8	8		136	136	
64	64		0	0	
0	0		0	0	
166 μ sec.	148 μ sec.		230 μ sec.	212 μ sec.	

$N \leq 1$, Maximum time: 300 μ sec.
Minimum time: 144 μ sec.

$N \geq 2$, Maximum time: 236 μ sec.
Minimum time: 148 μ sec.

Note: In cases I and II, maximum addition times are 4 μ sec. less than shown. (If (u) and (v) are both positive, K = 0.)

Floating point multiply (FMuv)

MP 0 (Unpack (u) sequence)	$7 + (u_{35})$
1 (Unpack (v) sequence)	7
*2 (Multiply sequence)	$40 + \sum_{i=1}^{26} (u_{35} \oplus u_i) + 2(u_{35} \oplus u_0)$
5 (NRP sequence)	$20 + 2k$
6 & 7 (Set up NI)	7

Total (clock pulses) $81 + (u_{35}) + 4\sum_{i=1}^{26}(u_{35} \oplus u_i) + 2(u_{35} \oplus u_0) + 2k$

Total (μ sec.) $162 + 2(u_{35}) + 8\sum_{i=1}^{26}(u_{35} \oplus u_i) + 4(u_{35} \oplus u_0) + 4k$

Maximum time: 380 μ sec.

Minimum time: 162 μ sec.

*If (u) is negative, the complement of (u) is sent to Q. Therefore, Q_{35-27} is always zero, and (Q_{26-0}) may be the complement of (u_{26-0}).

Floating point divide (FDuv)

MP 0 (Unpack (u) sequence)	$7 + (u_{35})$
1 (Unpack (v) sequence)	7
2 (Initial shift of (u)	36
3 (Divide sequence)	222
4 (Q → A sequence)	6
5 (NRP sequence)	$39 + 2k$
6 & 7 (Set up NI)	7

Total (clock pulses) $324 + (u_{35}) + 2k$

Total (μsec.) $648 + 2(u_{35}) + 4k$

Maximum time: 654 μ sec.

Minimum time: 648 μ sec.

Floating point polynomial multiply (FPuv)

MP	0	(Unpack (Q) sequence)	$5 + (Q_{35})$
	1	(Unpack (u) sequence)	7
	2	(Multiply sequence)	$40 + 4\sum_{i=1}^{26} (Q_{35} \oplus u_i) + 2(Q_{35} \oplus u_0)$
	(3)	(NRP (Q) · (u) sequence)	14
	(4)	Unpack (v) sequence	$7 + (v_{35})$
	3^1	(Initial alignment)	$1 + 3(N_9)$
	4^1	(Final alignment)	$4 + 2(N_9) + 2|N|$
	5	(NPP sequence)	$12 + (34 - |N|) + 2K$
	6&7	(Set up NI)	7

Total (clock pulses): $97 + (Q_{35}) + 4\sum_{i=1}^{26}(Q_{35} \oplus u_i) + 2(Q_{35} \oplus u_0) + 5(N_9) + 2|N| + (34 - |N|) + 2K$

Total (μ sec.): $194 + 2(Q_{35}) + 8\sum_{i=1}^{26}(Q_{35} \oplus u_i) + 4(Q_{35} \oplus u_0) + 5(N_9) + 4|N| + (68 - 2|N|) + 4K$

Maximum and minimum times depend upon the value of N as well as (Q).

(See the four cases given under Floating add and subtract.)

Taking the largest maximum (N=1) and the smallest minimum (N = 0), the maximum and minimum time are:

Maximum time (N = 1): 619 μ sec.

Minimum time (N = 0): 262 μ sec.

Floating point inner product (FIuv)

MP		
0	$(Q \rightarrow F_4$ sequence)	7
1	(Unpack (u) sequence)	$7 + (u_{35})$
(2)	(Unpack (v) sequence)	7
(3)	(Multiply sequence)	$40 + 4\sum_{i=1}^{26} (u_{35} \oplus u_1) + 2(u_{35} \oplus u_0)$
(4)	(NRP (u) · (v) sequence)	14
2^1	(Unpack (F_4) sequence)	7
3^1	(Initial alignment)	$1 + 3(N_9)$
4^1	(Final alignment)	$4 + 2(N_9) + 2|N|$
5	(NRP sequence)	$12 + (34 - |N|) + 2K$
6&7		7

Total (clock pulses): $106 + (u_{35}) + 4\sum_{i=1}^{26}(u_{35} \oplus u_1) + 2(u_{35} \oplus u_0) + 5(N_9) + 2|N| + (34 - |N|) + 2K$

Total (μ sec.): $212 + 2(u_{35}) + 8\sum_{i=1}^{26}(u_{35} \oplus u_1) + 4(u_{35} \oplus u_0) + 10(N_9) + 4|N| + (68 - 2|N|) + 4K$

Maximum and minimum times depend upon the value of N as well as (u).

(See the four cases given under Floating add and subtract.)

Taking the largest maximum (N = 1) and the smallest minimum (N = 0), maximum and minimum times are:

Maximum (N = 1): 637 μ sec.

Minimum (N = 0): 280 μ sec.

Floating point unpack (UPuv)

MP 0	(Unpack (u) sequence)	$7 + (u_{35})$
1	($u_m \rightarrow m$ sequence)	5
2	($u_c \rightarrow s$ sequence)	1
5	($u_c \rightarrow v$ sequence)	5
6&7	(Set up NI)	8

Total (clock pulse) $26 + (u_{35})$

Total (μ sec.) $52 + 2(u_{35})$

Floating point normalize pack (NPuv)

MP 0	(Read (v) sequence)	7
1	($v_c \rightarrow c$ sequence)	1
2	(Read (u) sequence)	7
3	($u \rightarrow A$ sequence)	3
4	(NRP sequence)	$39 + 2K$
5	(Write in (u) sequence)	7
6&7		8

Total (clock pulses) $72 + 2K$

Total (μ sec.) $144 + 4K \quad (9 > K \geq 0)$

Maximum time: 180μ sec.

Minimum time: 144μ sec.

Floating point normalize exit (NEj=)

MP 0	(Clear x)	1
1	(Set NE FF	1
5	- - - - - -	1
6&7		7

Total (clock pulses)   10

Total (μ sec.)   20