

Digital Computer Laboratory
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SUBJECT: WWI Operation Times

To: S&EC Group, Group 61, Group 64

From: H. Denman

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Abstract: The operation times for the WWI instructions (except bo and bi) have been both calculated (based on the computer operation) and measured (using the real time clock). The results are given.

The operation times have been measured for the WWI Computer, with the following conditions:

1. It is assumed that the instruction is stored in MCM, and that if the address of the instruction refers to a storage address, this address is also in the MCM.

2. The times listed below indicate the number of pulses, from the fundamental computer pulse generator, required for each operation. This generator is supposed to operate at exactly 1 megacycle per second. If it does, these numbers are also the number of microseconds required for each operation. However, this pulse generator is LC controlled, and therefore may not operate at exactly 1 megacycle. Hence, the actual times for the operations may not be these numbers of microseconds. The measurements made during this test indicate that the error in assuming the pulses to be exactly 1 microsecond apart was less than $\frac{1}{2}$ of 1% at the time of the test.

3. For In-Out instructions (si, rd, rc), it is assumed that the interlock is cleared and any delay counts associated with these orders are ignored. Times for bi and bo are not given, as they are chiefly dependent on the In-Out equipment referred to by the previous si instruction.

These times have been calculated on the basis of the operation of the computer, and were verified by measurements using the real-time clock:

NUMBER	OPERATION	TIME, in μ sec. (or clock pulses)
0	si	31 (see 3 above)
1	illegal inst.	
2	bi	not meas. (see 3 above)
3	rd	16 " " "
4	bo	not meas. " " "
5	rc	24 " " "
6	illegal inst.	
7	sb	16
8	ts	24
9	td	32
10	ta	32
11	ck	24
12	ab	32
13	ex	32
14	cp	16
15	sp	16
16	ca	24
17	cs	24
18	ad	24
19	su	24
20	cm	24
21	sa	24
22	ao	32
23	dm	24
24	mr	} 36-43
25	mh	
		Time for this operation varies in accordance with the number of 1's in the magnitude of the number in the AC when this instr. is given. The minimum time (36 μ sec) is for all 0's in AC ; the maximum (43 μ sec) for all 1's in AC . The time is a linear function of the number of 1's between 1 and 15, rounded up, and therefore the average time for this instr. for random numbers is 39.5 μ sec.
26	dv	73

NUMBER	OPERATION	TIME, in μ sec. (or clock pulses)
27	slh n	16-41 Time for this operation varies in accordance with the number n in the addresses of these instructions. n is taken modulo 32. The minimum time(16 μ sec.) is for n=0;the maximum time(41 μ sec.) for n=31. However, the time is not a linear function of n between these points, due to the occurrence of restoration pulses.
	slr n	
28	srh n	
	srr n	
29	sf	33-31 Time for this instruction varies in accordance with the number of 0's between the binary point and the first 1 in the magnitude of the binary fraction represented by the number in the AC and BR. If the magnitude of the number in the AC and BR is $\geq \frac{1}{2}$, the number is scale factored 0 times, giving the minimum time of 33 μ sec. for this operation. If the magnitude of the number in the AC is 0 and the BR contains all 0's, the operation takes the maximum time of 31 μ sec. (giving scale factor of 33). The time is not a linear function of n between these values, due to restoration pulses.
30	clh clc	Same as shift orders above (16-41 μ sec.)
31	md	24

Signed: H. H. Denman
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Approved: CWA
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