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Floating Point Coprocessor Upgrade*

T. WEBER

Stanford Linear Accelerator Center
Stanford University, Stanford, California, 94305

ABSTRACT

A method was developed to increase the throughput of the Hewlett Packard, 98635A floating point processor equipped, model 236C computer. The increase was carried out in three phases each with a clock and or chip change during the modification. Two programs were written to test the results and evaluate the increases in performance made to the computer. The first one shows reduction in processing times of 34.3%, while the other recorded 34.6%.

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1. Introduction

There is always been an interest in increasing the throughput of any computer and the model 236C is not unique in this respect. This interest first lead to the purchase of the HP 98635A floating point card. While this satiated the desire for speed the effect soon wore off and the search was on again for more speed from the computer. An obvious choice seemed to be the 09826-69517 MMU processor board as I was quoted the price for a exchange board. This proved to be in error and the actual price for the out right purchase very high and there for not cost effective. This did lead to the purchase of a new 12 Mhz 68000 with the idea of changing the clock crystal as we had done to a IBM PC/AT some time earlier. However a letter to Jim Bailey in HP Design of November of 1986 from Stoney Burt provided crystal values to select from and prompted me to obtain some crystals and experiment. What followed was three separate modifications to the computer which will be discussed in chronological order.

2. Experimental Setup

Two programs were written to test operation and presence of the floating point card. The first is from the installation manual for the card and tests the time ratio with and without the card running. The other is for checking the timing between the processor and the floating point card. It checks to see if the card is present and keeps track of the number of times it finds or doesn't find the card. Two other programs were used to test through put of the system. The first is called the Watt test and is a simple sine calculation repeated, while the second the Rinta test performs some arithmetic and loop operations. These two programs were used to measure the elapsed time to run each one for the three modifications made to the computer. The existing stock clocks (16 and 10 Mhz remembering HP divides by 2 for the actual frequency) were tested, for bench mark numbers to be used in evaluating the tests for improvements, with times of:

12.45 seconds for the Watt test
4.13 seconds for the Rinta test.

Next the system was disassembled and the clock for the processor removed and replaced with a socket. Clocks of 18.432 Mhz and 20 Mhz were tested but only the 18.432 Mhz would work with the floating point. It was at this point that the program to test for the card was developed. The combination of a 18.432 Mhz and the 10 Mhz stock clock on the floating point gave times of:

11.32 seconds for the Watt test
3.63 seconds for the Rinta test.

The second step was to change the clock on the floating point card to try and get it to work. It too was changed to a socket to allow easy changing and protect the board. The final clock for the system was chosen to be 20 Mhz and a clock of 32 Mhz was found to work with the faster CPU clock, at the expense of 1 HP 98256A 256Kbyte memory board. While the system did work the floating point became erratic with a few minutes use in a long calculation. Tests proved it to be heat build up in the chip and relief was obtained from a fin heat exchanger added to the chip with epoxy. The then present air conditioning in my office permitted this mode of operation for about 4 months but, they improved the system and the chip would now act up once in a while. The apparent solution was to ask about a higher temperature version of the 16081 from National Semiconductor. Mr. Carl Ching from National came to my aid with a 15 Mhz version now called NS32081D-15. This is soldered directly into the HP 98635A and now operates with out any external aid giving times of:

9.65 seconds for the Watt test
3.29 seconds for the Rinta test.

The last change is the replacement of the system clock with a 25 Mhz clock to reduce the time even more. At this time the 8 Mhz CPU was replace with the 12 Mhz that had been bought back at the start as a precaution that CPU might fail at the higher rates. Attempts at a faster floating point clock failed the test program for finding the floating point card. The remaining difficulty is the failure of the HP 98257A 1.02Mbyte RAM to operate while all the HP 98256A 256Kbyte RAM now functions at the higher speed. I believe that with a little work the HP 98257A can be reclaimed. This combination 25 Mhz and 32 Mhz gives the following times of:

8.17 seconds for the Watt test
2.70 seconds for the Rinta test.

3. Results and costs

The system runs all the software I have for it without any problems other then the above failure of the memory card. The table will sum up the changes, increases in performance, and the over all cost for each modification.

	STOCK	MOD 1	MOD 2	MOD 3
WATT TEST	12.45	11.32	9.65	8.17
% CHANGE		-9.1%	-22.5%	-34.4%
RINTA TEST	4.13	3.63	3.29	2.70
% CHANGE		-12.1%	-20.3%	-34.6%
COST	N A	$3.19	$124.86	$40.25

4. acknowledgement

I would like to thank Ron Badger,Carl Ching, and Dimitri Talaska for their assistance and faith in the project.

5. Programs

I have included copies of the test runs and the testing programs.

STOCK- 16/10

RINTA-TEST

```
1       DIM M(5)
10      Tyme0=TIMEDATE MOD 86400
20      K=0
30      K=K+1
40      A=K/2*3+4-5
50      GOSUB 130
51      FOR I=1 TO 5
52      M(I)=A
53      NEXT I
54      IF K<1000 THEN 30
60      Tyme1=TIMEDATE MOD 86400
61      PRINT "NUMBER OF TIMES";K,"ELASPED TIME";INT(10000*(Tyme1-Tyme0))/10000
130     RETURN
140 END
NUMBER OF TIMES 1000            ELASPED TIME 4.1299
1       REM TEST
10      Tyme0=TIMEDATE MOD 86400
20      A=1
30      FOR N=1 TO 10000
40      B=SIN(A)
50      NEXT N
60      Tyme1=TIMEDATE MOD 86400
61      PRINT "NUMBER OF TIMES";N-1,"ELASPED TIME";INT(10000*(Tyme1-Tyme0))/10000
70      END
NUMBER OF TIMES 10000           ELASPED TIME 12.4499
```

105.90

Seconds.

System Error = -12/0

MOD 1 18.432/10

```
1       REM RINTA_TEST
3       DIM M(5)
10      TymeO=TIMEDATE MOD 86400
20      K=0
30      K=K+1
40      A=K/2*3+4-5
50      GOSUB 130
51      FOR I=1 TO 5
52      M(I)=A
53      NEXT I
54      IF K<1000 THEN 30
60      Tyme1=TIMEDATE MOD 86400
61      PRINT "NUMBER OF TIMES";N-1,"ELASPED TIME";INT(10000*(Tyme1-TymeO))/10000
130     RETURN
140 END
NUMBER OF TIMES-1    ELASPED TIME 3.63
10      TymeO=TIMEDATE MOD 86400
20      A=1
30      FOR N=1 TO 10000
40      B=SIN(A)
50      NEXT N
60      Tyme1=TIMEDATE MOD 86400
61      PRINT "NUMBER OF TIMES";N-1,"ELASPED TIME";INT(10000*(Tyme1-TymeO))/10000
70      END
NUMBER OF TIMES 10000          ELASPED TIME 11.32
```

```
NUMBER OF TIMES 10000          ELASPED TIME 9.6499

1       REM WATT'S SIN TEST
10      Tyme0=TIMEDATE MOD 86400
20      A=1
30      FOR N=1 TO 10000
40      B=SIN(A)
50      NEXT N
60      Tyme1=TIMEDATE MOD 86400
61      PRINT "NUMBER OF TIMES";N-1,"ELASPED TIME";INT(10000*(Tyme1-Tyme0))/10000
70      END
```

```
NUMBER OF TIMES-1    ELASPED TIME 3.29
```

```
1       REM RINTA'S TEST
3       DIM M(5)
10      Tyme0=TIMEDATE MOD 86400
20      K=0
30      K=K+1
40      A=K/2*3+4-5
50      GOSUB 130
51      FOR I=1 TO 5
52      M(I)=A
53      NEXT I
54      IF K<1000 THEN 30
60      Tyme1=TIMEDATE MOD 86400
61      PRINT "NUMBER OF TIMES";N-1,"ELASPED TIME";INT(10000*(Tyme1-Tyme0))/10000
130     RETURN
140 END
```

```
10     REM RINTA TEST
20     DIM M(5)
30     Tyme0=TIMEDATE MOD 86400
40     K=0
50     K=K+1
60     A=K/2*3+4-5
70     GOSUB 150
80     FOR I=1 TO 5
90     M(I)=A
100    NEXT I
110    IF K<1000 THEN 50
120    Tyme1=TIMEDATE MOD 86400
130    PRINT "NUMBER OF TIMES";N-1,"ELASPED TIME";INT(10000*(Tyme1-Tyme0))/10000
140    STOP
150    RETURN
160 END
```

NUMBER OF TIMES-1 ELASPED TIME 2.7

```
10     REM WATT TEST
20     Tyme0=TIMEDATE MOD 86400
30     A=1
40     FOR N=1 TO 10000
50     B=SIN(A)
60     NEXT N
70     Tyme1=TIMEDATE MOD 86400
80     PRINT "NUMBER OF TIMES";N-1,"ELASPED TIME";INT(10000*(Tyme1-Tyme0))/10000
90     END
```

NUMBER OF TIMES 10000 ELASPED TIME 8.16

```
10     REM THIS IS HP'S FLOATING POINT TEST
20     INTEGER I
30     CONTROL 32,2;0
40     GOSUB Time_it
50     X=Z
60     Timex=TIMEDATE-TO
70     CONTROL 32,2;1
80     GOSUB Time_it
90     Y=Z
100    Timey=TIMEDATE-TO
110    IF (Timex/Timey)2) AND (X-Y=0) THEN
120    PRINT "OKAY"
130    ELSE
140    PRINT "NG"
150    END IF
160    STOP
170 Time_it:   !
180            TO=TIMEDATE
190            FOR I=1 TO 1000
200            Z=3.1*9.3*5.3*SIN(LOG(2.718))
210            NEXT I
220            RETURN
230            END
```

```
10     REM THIS TEST TO FIND THE FLOATING POINT BOARD
20     REM HIT ANY KEY TO STOP AND DISPLAY THE RESULTS
30     No_body_home=0
40     Okay=0
50     CONTROL 32,2;1
60     STATUS 32,2;A
70     IF A=1 THEN
80     Okay=Okay+1
90      ELSE
100    No_body_home=No_body_home+1
110      END IF
120  ON KBD GOTO 140
130  GOTO 50
140     PRINT "OKAY=",Okay
150     PRINT "NO BODY HOME",No_body_home
160     END
```