CSIRAC NOTES 21/10/62

I. INTRODUCTION

Some changes have occurred due to modifications to the timing of the machine to achieve higher operating speed. Descriptions are given in these notes of the different modes of machine operation, of optimization of command addresses to take full advantage of the higher speeds now available, there is a discussion of current machine speeds and idiosyncrasies (superseding previous notes), and finally there are some notes on the programming of left shift commands.

II. MACHINE SPEEDS AND MODES

1. Commands calling peripheral equipment.

Drum	20 m, sec/cycle of 1024 locations
Punch 5-hole) 20 cps	50 m, sec/character
" (12-hole) 15--18 cps	
Input (5-hole) 100 cps	10 m. sec/character
" (12-hole) 35-50 cps	29-20 m. sec/tape row

2. Machine modes

Mode 0. The old slow speed - this is no longer available

Mode 1. Available with the "speed-up" switch "off" (up)
This is similar to the old "speed up" mode. Command times are:

Multiplication and left shift 4 m sec.

other commands, basic time 2 m sec.
If address is 12, 13 or 14 (mod 16) add 1 m sec.

If store location is 12, 13 or 14 (mod 16) add 1 m sec.

If both, add 2 m sec.

Hence commands may take 2, 3 or 4 m sec.

Mode 2. Available with the "speed up" switch "on" (down), and the black switch to the right of it up. Command times are:

Multiplication 3-4 m sec., depending on optimization

Left shift 1-3 m sec., depending on number of left shifts, and optimization

Other commands if optimized 1 m sec.
not optimized not> 2 m sec.

Mode 3. Available with the "speed up" switch "on" (down), and the black switch to the right of it down. Command times are:

Multiplication and left shift. Same as mode 2.

Other commands if optimized ½ m sec.
not optimized not> 1.5 m sec.

III. OPTIMIZATION RULES

1. These relate only to operation in modes 2 and 3

2. They involve the relation between the P11-P14 digits of a command and its absolute store location (mod 16). For mode 2 there is a range of optional addresses for a particular store location; for mode 3 the optimal address is unique (See Table I).

3. Addresses optimal for mode 3 are also optimal for mode 2.

4. For mode 3, commands in locations 15 (mod 16) take a minimum of 1 1/1 6 m sec.

5. For mode 3, the optimum addresses shown give maximum speeds; for a given location different addresses will give a range of command times between ½ and 1.5 m sec.

TABLE I. OPTIMAL ADDRESSES

Store location	p11-p14 digits of address								
0	5	6	7	8	9	10	11	12	8
1	6	7	8	9	10	11	12	13	9
2	7	8	9	10	11	12	13	14	10
3	8	9	10	11	12	13	14	15	11
4	9	10	11	12	13	14	15	0	12
5	10	11	12	13	14	15	0	1	13
6	11	12	13	14	15	0	1	2	14
7	12	13	14	15	0	1	2	3	15
8	13	14	15	0	1	2	3	4	1
9	14	15	0	1	2	3	4	5	0
10	15	0	1	2	3	4	5	6	3
11	0	1	2	3	4	5	6	7	2
12	1	2	3	4	5	6	7	8	5
13	2	3	4	5	6	7	8	9	4
14	3	4	5	6	7	8	9	10	7
15	4	5	6	7	8	9	10	11	6

IV. IDIOSYNCRASIES

1. General. The peripheral units of the machine (source I, destinations OT and OP) cause the machine to stop if the appropriate peripheral unit has not completed its previous operation, and the machine re-starts when it receives a ready signal from the unit. If the command on which the machine stopped was preceded by a PK command, digits from the PK source will be lost during such a stop.

Special circuitry has been provided to allow drum commands to be modified by PK commands. The operation is as follows:

(a) Drum read commands. When the read command is encountered, the address is noted and the machine stops to await the arrival of the drum corresponding to this address. At the appropriate time the content of the drum cell is transferred to the drum buffer register, and the machine re-starts, executing the drum read order as stored by transferring the content of the buffer register to the designated destination.

(b) Drum write commands. When the write command is encountered, the content of the appropriate source is transferred to the drum buffer register, the address noted, and the machine stops to await the arrival of the drum position corresponding to this address. At the appropriate time the content of the drum buffer register is transferred to the drum, and the machine restarts, executing the next command.

2. Deletions. Two idiosyncrasies previously noted no longer apply, as follows:

(a) Drum commands may now be located anywhere for use with the machine in any mode.

(b) Time position and location 11 (mod 16) are now no different to others.

3. Input commands. Should not have an address, unless the machine is not waiting on the reader when the command is encountered. This rule is applicable even if the address is vacuous, and becomes more important as the machine speed is increased.

Preceding input commands by a PK command is dangerous, see 1 above.

4. Output commands are modified by PK commands only if the machine is not waiting on the punch (or teleprinter). See 1 above.

5. Drum restrictions

(a) PK commands modifying lower-half digits are allowed provided only that the assembled command does not become a drum read command. See 1 above.

(b) Drum locations pass the heads in order of ascending address. Programs must be arranged so that after a drum write command, the drum address will pass 31 31 before the next drum command (read or write) is executed. This is required to ensure that the drum clock time is corrected after each write command - the write pulse can upset the clock count, and the correction occurs after the 31 31 address. This can be ensured by

(i) putting the uppermost address first - the address must pass 31 31 to reach a lower address

or (ii) allow enough time to pass the second address. This latter procedure could be valid in a particular case for mode 1 but not for mode 2 etc., so that procedure (i) is preferred.

6. The left shift operation has a different coding if the machine is operated in mode 3. As previously, the operation will only occur if the destination L receives a PS digit from any source. If it does receive such a digit, the number of left shifts that occurs depends on the p11-p14 digits of the command, as given below (Table 2)

TABLE 2 - LEFT SHIFT CODING

No of shifts	p11-p14 digits of address	
Modes 1 and 2		Mode 3
½	15	0
1	0	15
1½	1	13
2	2	11
2½	3	9
3	4	7
3½	5	5
4	6	3
4½	7	1
5	8	14
5½	9	12
6	10	10
6½	11	8
7	12	6
7½	13	4
Disallowed because of variable effect (0 or 8)	14	2

7. The command MA XB tends to give trouble and may never be really reliable.

8. The trigger stop will fail if it is attempted to stop

   (a) when the lower half of S is not clear

   (b) on a drum write command

   (c) on a multiply or left shift command

Exotic combinations such as

I T

MA MA

tend to give exotic results, and any such combination should be investigated thoroughly before being used.

V. OPTIMIZATION TECHNIQUES

1. Program by R. W. Muncey (12-a)

(a) Accepts 12 hole program tape and produces optimized version on 12 hole punch, preceded by a primary and a secondary routine which will be assembled in cells 23 6 to 23 31.

(b) The program to be optimized is understood to be written so that it will operate in either mode - i.e, no change is made to the coding of left shift commands.

(c) Constants, or program parameters preceded by 03Y and followed by 07Y will be unaltered. (These declarations control the print out case of the source and destination in the TSP program).

(a) The normal control declarations "T", "S", "A", "R", "D" are all acceptable, and are suitably handled.

(e) Special declarations called MA and M are allowed.

(i) MA This declaration is intended to cause the material following to be stored on the drum. The usual coding is

```
a, b T

     CA MA
```

wherein a, b is the location of the CA M command of the primary. This coding will be correctly translated if there is an additional X punch on the "T" row of the tape, **i.e.** 0Y becomes 0XY

(ii) M This declaration is intended to restore the primary to storing in the main store after having been storing in the drum. The usual coding is

```
D
  a, b CA M
       CA M
R
```

wherein a, b is as above. This coding will be correctly translated if there is an additional X punch on the "D" row of the tape, i.e. 6Y becomes 6XY.

(f) Translation will cease on receipt of 31 16 XY

2. Projected optimization programs.

Three other optimization programs are under development:

12-b Similar to 12-a above except that it will alter the coding of left shift commands from coding of modes 1, 2 to coding of mode 3.

5-a Identical to 12-a except that the output will be on 5-hole tape with a suitable boot-strap primary.

5-b Identical to 12-b except that the output will be as 5-a.

3. Program by W. Flower

Details not available at time of going to press.

VI. INTERPROGRAM

Interprogram is not valid in mode 3. Five hole versions of interprograms compiled before Nov. 1962 very often fail on input in mode 2, a closed loop is entered. This is caused by an addressed input command which is now encountered before the reader is ready. If the tape is marked near the point where input ceases, and then compared with a master tape attached to the cabinet holding the CSIRAC library tapes, it will be seen that two rows of tape need alteration. Instructions are written on the master tape.

VII. LEFT SHIFT CODING, PROGRAMMING SUGGESTIONS

1. Variation of the number of left shifts required by a count of 2 PE units in a D register with coding

```
D PK
PS L
```

or similar is much more difficult to devise for operation in mode 3, and will not be correctly translated by current optimization programs. Reference to a directory using a single PE count is possible, but would require a different directory for modes 1, 2 and mode 3.

```
e. g.      D PK )
       a,b M PK ) the directory being located at a
          PS L }
```

2. The sequence

```
  A SA }
8 0 K B } will cause a stop if the machine is
  PS L ) operated in mode 1 or 2
  B  T )
```

The sequence

```
    Z B }
8 0 K A )
   PS L } will cause a stop if the machine
   S  T )  is operated in mode 3
```

These sequences can be used to prevent a program being operated in an incorrect mode. The second of these sequences could be incorporated into a program written for mode 2, and when such a program was translated for mode 3 by 12-b or 5-b, it would then correctly stop if operated in mode 1 or 2.

3. The sequence

8 0 K A)

Z B)

PS L) will set D_x=PS in mode 1 or 2

X CA D) D_x clear in mode 3

Subsequently, the sequence

```
X SD CS ) will give the same number of left shifts
 a K PK ) irrespective of which mode the machine
 b PS L } is in.
```

b being the correct mode 1 or 2 coding and a + b (mod 16) the mode 3 coding for the number of left shifts desired. This type of technique enables a program to be valid for any mode.

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