T H E  U N I V E R S I T Y  O F  M I C H I G A N

Memorandum

# COMPARATIVE EVALUATION OF DIGITAL EQUIPMENT CORPORATION'S 340 AND 330 DISPLAY CONTROLS

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This evaluation was compiled during the development of the display specifications for one of the remote display consoles at The University of Michigan.

The DEC 330 Display is the name given the DEC 338 Buffered Display when it is supplied without the PDP-8. For purposes of this evaluation, the 330 and 340 are configured with standard options to have, as much as possible, the same capabilities.

The evaluation is divided into three basic sections. The first is a cost comparison. The second is a comparison of the execution time and instruction size for the basic operations causing display of information. The final section, which comprises the bulk of the evaluation, compares the equivalent instructions in each display.

The 330 Display Control is clearly the best display on an economic and technical basis. When these displays are compared in the environment of a PDP-7, one more factor should be noted. The 340 Display has a fair amount of software support on the PDP-7. The 330 Display can use the same display programs as the 338, but the control programs must be translated to the PDP-7 from the PDP-8. When the 330 Display is used on the PDP-7, only the low order 12 bits of the 18 bit word are used for display programs. This fact allows the display structure to be imbedded in a higher order data structure which could use the high order 6 bits for other information pertinent to the data structure. Thus, the 330 Display is probably the best display to connect to the PDP-7 in a research environment. In a production environment, more weight will probably have to be given to the software support of the 340.

| Cost | 340 Display | | 330 Display | |
|---|---|---|---|---|
| | Item | Subtotal | Item | Subtotal |
| Display | $25,800 | $25,800 | | |
| Subroutine Interface | 3,358 | 29,158 | $37,000 | $37,000 |
| Light Pen | 1,625 | 30,783 | | |
| Pushbutton Box | NA | | | |
| Character Generator | 11,600 | 42,383 | 6,000 | 43,000 |
| Interface to PDP-7 | 900 | 43,283* | 10,000 | $53,000 (DEC Interface) |
| | | | | or |
| | | | 1,000 | $44,000 (U of M Interface) |

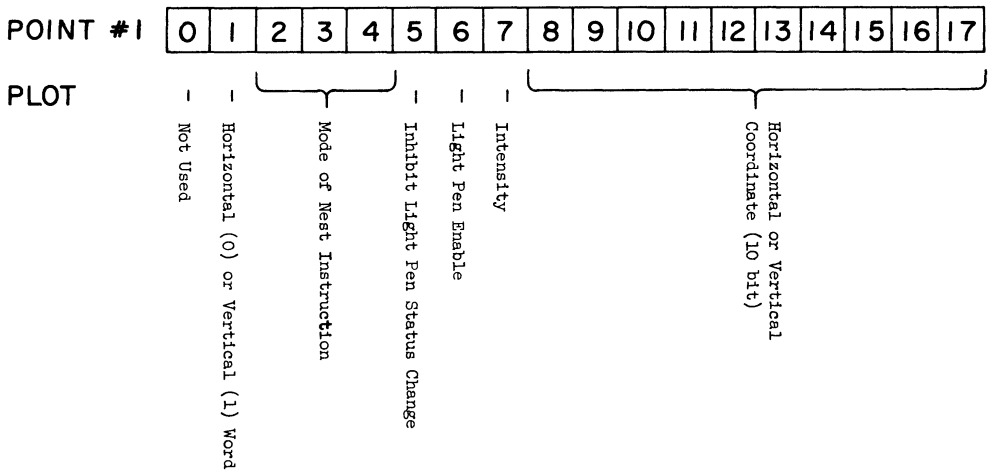
*Note: If the $5,000 cost of an additional pushbutton box on the 330 Display is used as an estimate for a pushbutton box on the 340 Display, the total 340 Display cost is $48,283.

## TIMING AND INSTRUCTION SIZE

(Display Instructions)

| Display Mode | Condition | No. of Core Accesses | | Speed (μsec) | | | | Speed per |
|---|---|---|---|---|---|---|---|---|
| | | | | Nonintensified | | Intensified | | |
| | | 340 | 330 | 340 | 330 | 340 | 330 | |
| Point (including graph) | Points close together | 2 | 1 or 2 | 36.8 | 6.5 | 36.8-71.6 | 6.5 | Point |
| | Points far apart | 2 | 1 or 2 | 36.8 | 35.5 | 36.8-71.6 | 35.5 | |
| Vector | Short vector | (7 bits) 1 | (4 bits) 1 | | | | | |
| | Vector and vector continue | (7 bits) 1 | (10 bits) 2 | 1.5 | 0.25 | 1.5 | 1.2 | |
| | Increment | 1/4 | 1/2 | 2.25 | 0.25 | 2.25 | 1.2 | |
| Character | Character | 1/3 | 1/2 + ~5 | ~35 | ~8 | ~40 | ~30 | Character |

## 340



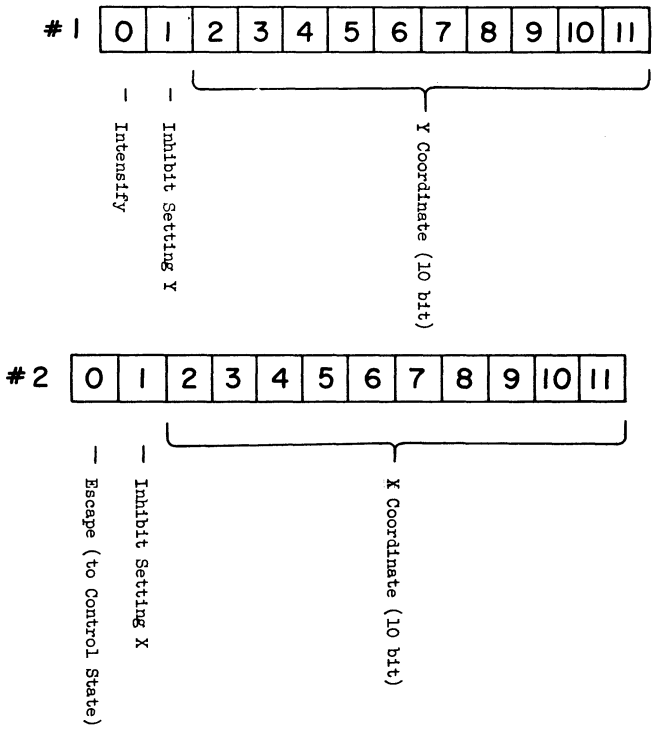

NOTES:

Requires two words if both coordinates are to change.
Mode of the next instruction must be specified.

TIMING:

Nonintensified = 36.8 μsec.
Intensified = 36.8 - 71.6 μsec.
(regardless of position relative to the last point)

## 330




NOTES:

Requires two words, even if only one coordinate changes.
Next instruction assumed to be a point plot, unless the escape bit is set.

TIMING:

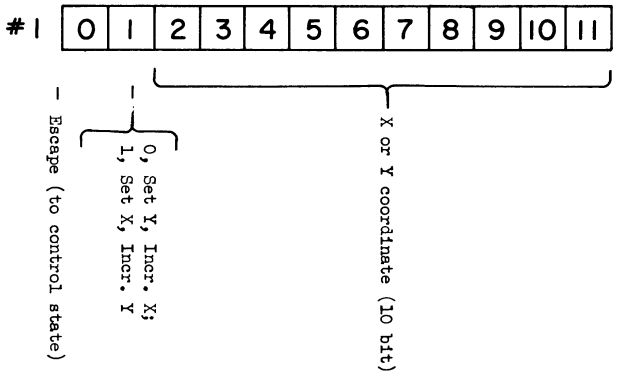
Nonintensified—same as intensified
Intensified, close to last = 6.5 μsec.
Intensified, far from last = 35.5 μsec.

## 340

GRAPH

PLOT Not Available

## 330




NOTES:

Requires one word.

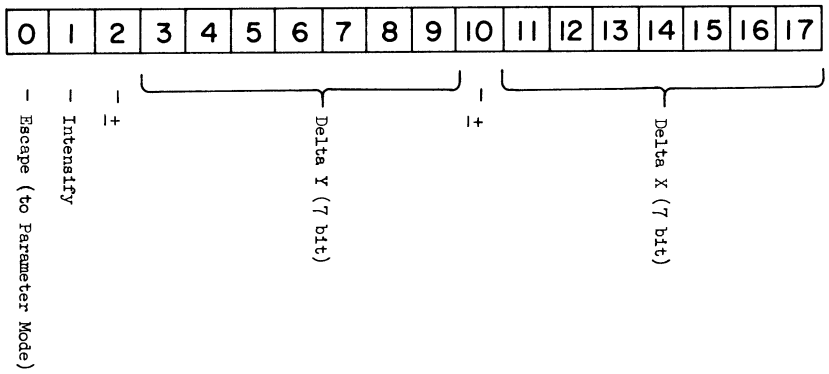
Next instruction assumed to be a graph. plot unless the escape bit is set.

TIMING:

| | | |
|---|---|---|
| Nonintensified | = | 0.3 μsec |
| Intensified close to last | = | 6.5 μsec |
| Intensified-far from last | = | 35.5 μsec |

340

VECTOR #1 and VECTOR CONTINUE




NOTES:

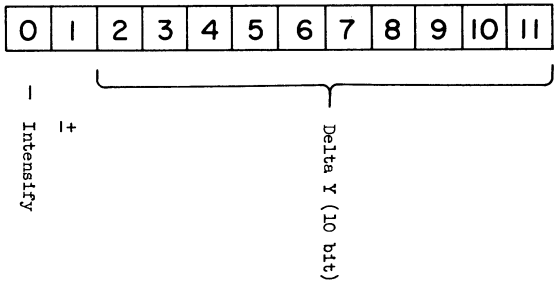
On times one scale, maximum vector size is 1/8 of raster size.
Only one core word required.
Mode of next same unless escape.

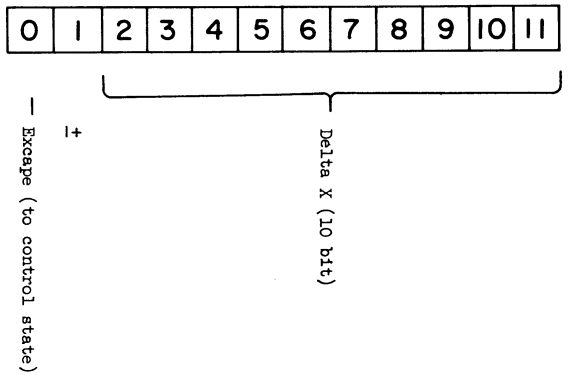
TIMING (per point):

Nonintensified or intensified = 1.5 μsec.

330

#1




NOTES:

On times one scale, maximum vector size is the full raster size.
Two core words required.
Mode of next is same unless escape.

TIMING (per point):

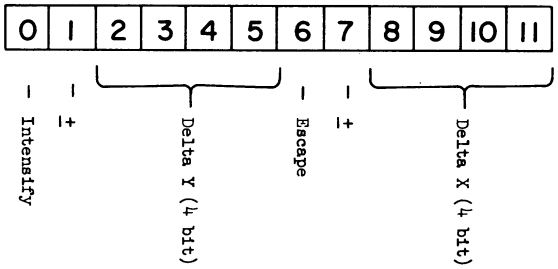
Nonintensified = 0.25 μsec.
Intensified = 1.2 μsec.

340

SHORT Not Available

VECTOR (Use Vector)

330




NOTES:

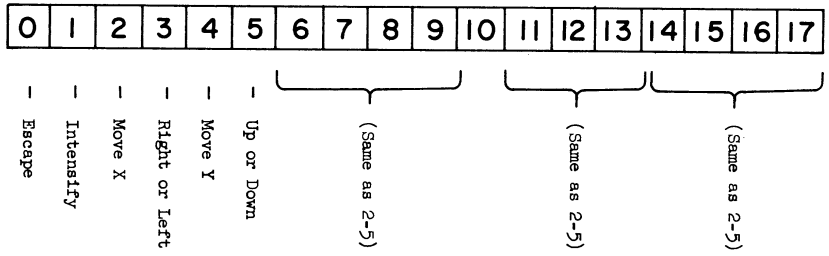
On times one scale, maximum vector size is 1/64 raster size.
Requires only one word of core.

TIMING (per point):

Nonintensified = 0.25 μsec.
Intensified = 1.2 μsec.

## 340

INCREMENT




NOTES:

Only one move may be made in one of the eight primary directions for each increment instruction.

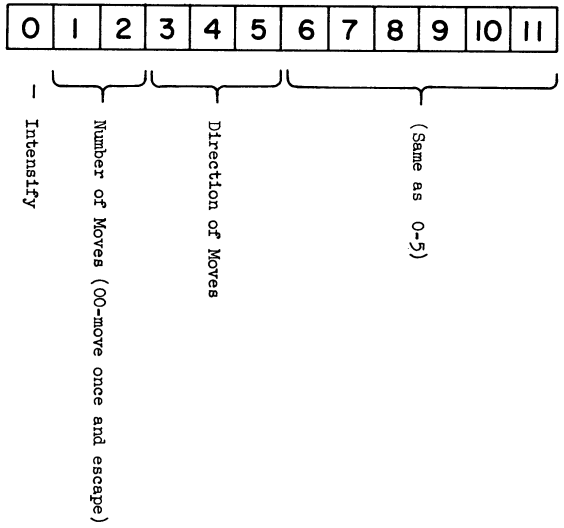
Four instructions are packed per word.

Mode of next same unless escape.

TIMING (per point):

Nonintensified or intensified = 2.25 μsec.

## 330




NOTES:

One, two, or three moves in one of the eight primary directions.

Two instructions are packed per word.

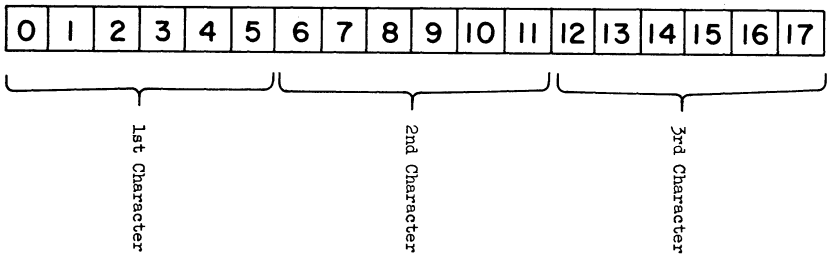
Mode of next same unless escape.

TIMING (per point):

Nonintensified = 0.25 μsec.
Intensified = 1.2 μsec.

## 340

CHARACTER (Optional)



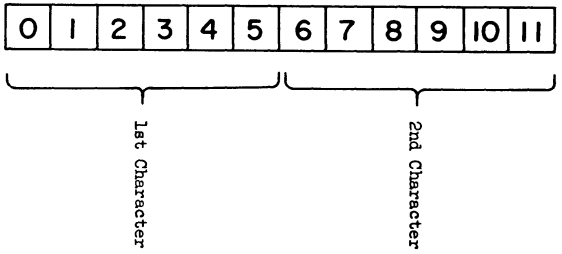

NOTES:

Character generator is a fixed character set. Characters are drawn by moves around a 5 x 7 matrix.

TIMING (per character):

Variable - average time 35-40 μsec.

## 330




NOTES:

6 bit code specifies an address in a dispatch table.

The dispatch table holds pointers by display sequences describing the characters in increment or short vector instructions.

TIMING (per character):

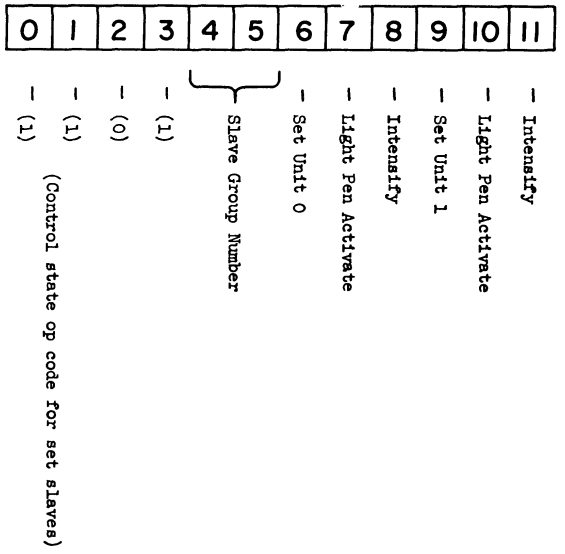
Variable - average time 35-40 μsec.

NOTES:

The display is stopped and an interrupt is generated in the processor if the appropriate bit is set in control state instruction with op code "1."

This is one of the automatically decoded control state instructions.

## 330



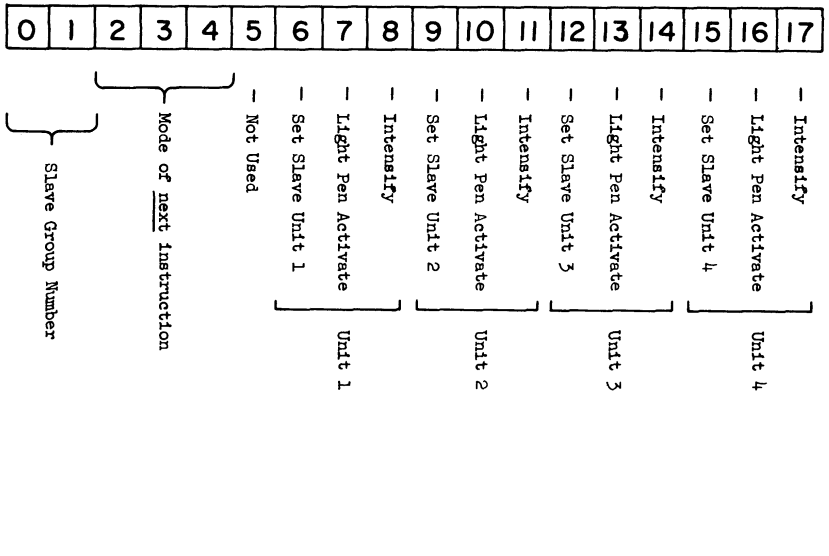

NOTES:

A total of 8 slaves may be controlled.

This is one of the automatically decoded control state instructions.

## 340

SLAVES (Optional)

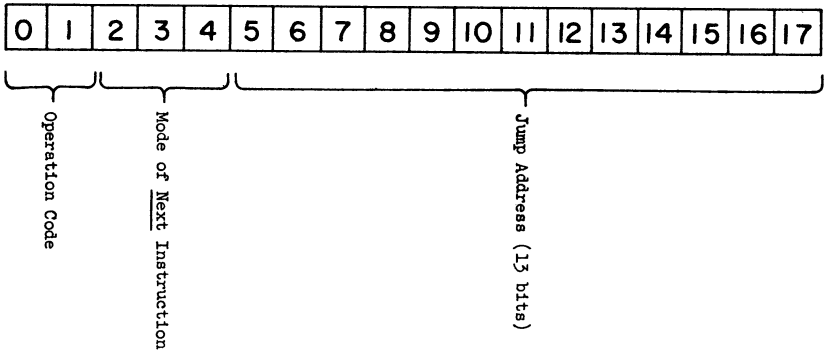



NOTES:

A total of 16 slaves may be controlled.

## 340

SUBROUTINE MODE (JUMP) # 1




00 Not Used

01 Stored the number in the address save register as a jump instruction with that number as address in the address specified

10 Display Jump (simple control jump)

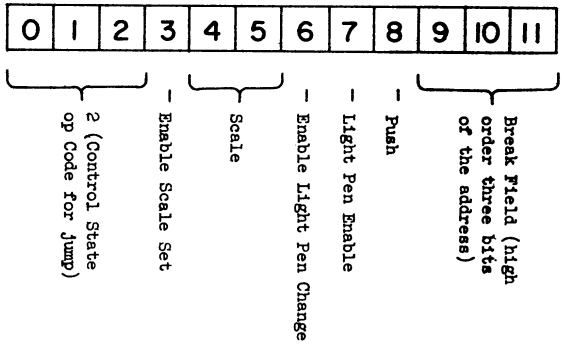
11 Display jump and save the address of this instruction plus one in the address save register.

NOTES:

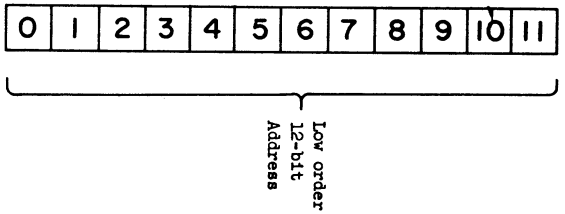
No provision for saving display status on subroutine entry.

## 330

#1



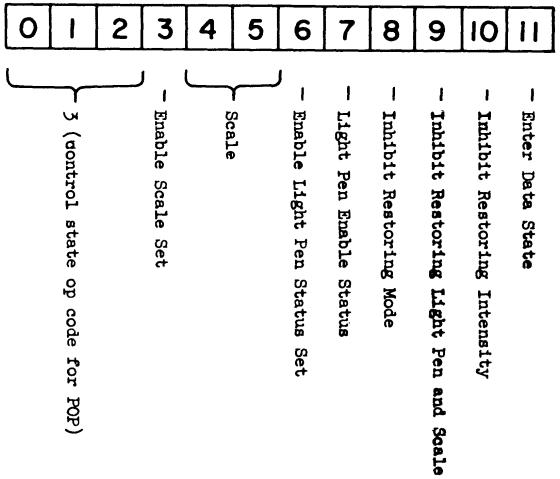

#2




NOTES:

Requires 2 words.
The total jump address size is 15 bits.
The push saves the (current address plus one), light pen status, scale, mode, and intensity on a pushdown list.

## 330




NOTES:

The pop jump transfers control to the address in the last entry on the pushdown list.

Scale and Light Pen Setting overrides the inhibits.

The inhibits override the automatic restoration of mode, light pen, scale, and intensity from the last entry on the pushdown list.

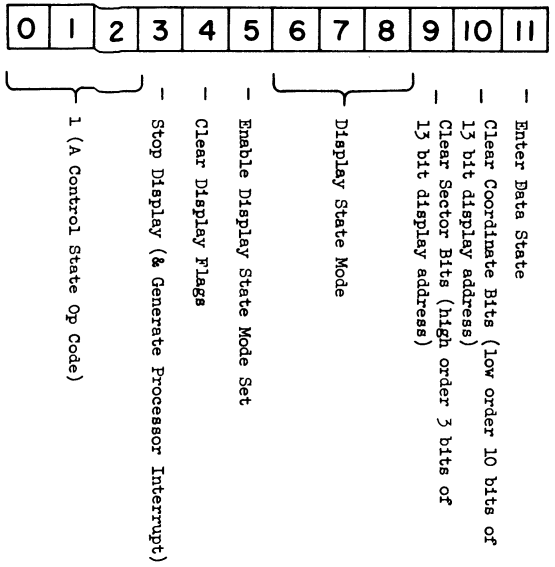
## 340

**POP** Not Available

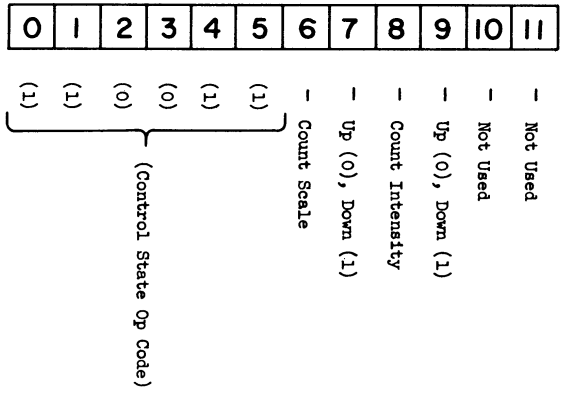
# INSTRUCTIONS AVAILABLE ON THE 330

## ( NOT AVAILABLE ON THE 340 )

**MODE**




**COUNT**



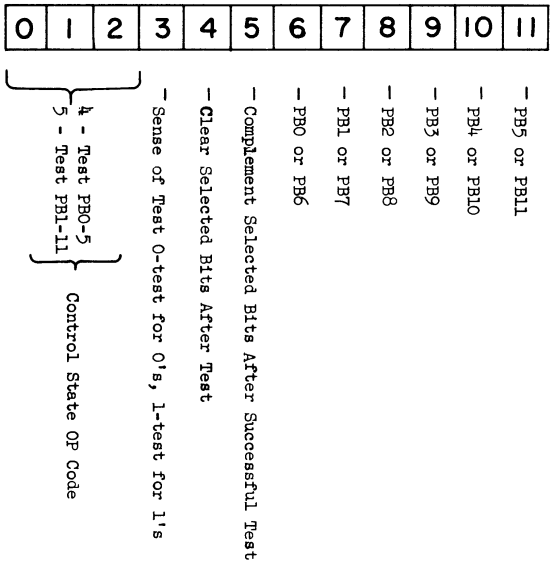

NOTES:

The intensity and scale registers will not overflow or underflow.

# INSTRUCTIONS AVAILABLE ON THE 330

## ( NOT AVAILABLE ON THE 340 )

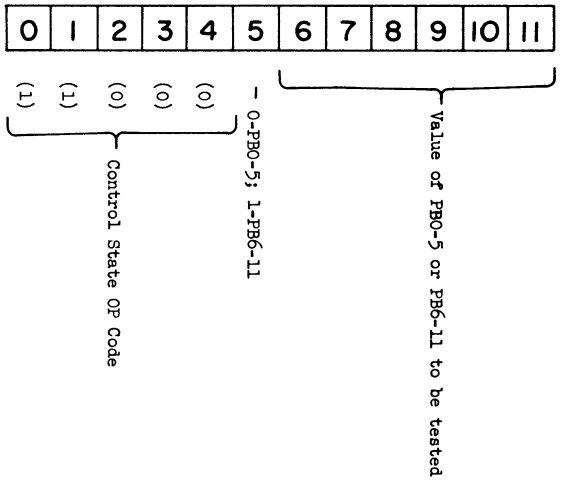
**CONDITIONAL SKIP (On pushbuttons)**




NOTES:

This instruction skips two core locations.

**ARITHMETIC COMPARE (On push-buttons)**




NOTES:

This instruction skips two core locations if comparison is unsuccessful.

## INSTRUCTIONS AVAILABLE ON THE 330

## ( NOT AVAILABLE ON THE 340 )

### AUTOMATIC SCISSORING:

The capability of automatic scissoring and specification of "paper" size is provided with the 13 bit X and Y address registers.

### SKIP ON FLAGS

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | – | – | – | – | – | – |

- 11 — Not Used
- 10 — Not Used
- 9 — Skip if PB6-11 Hit Flag = 0
- 8 — Skip if PB0-5 Hit Flat = 0
- 7 — Skip if not in Sector Zero (High order 3 bits of 13 bit X and Y address)
- 6 — Skip Unconditionally
- 5 (0)
- 4 (1)
- 3 (0)
- 2 (0)
- 1 (1)
- 0 (1)

Control State Op Code

# IOT INSTRUCTIONS

## (PDP-7 to Display)

### 340

1. Read display address counter
2. Skip on edge violation
3. Display resume
4. Skip on stop interrupt
5. Clear display address counter
6. Load display address counter (display start)
7. Skip on light pen flag
8. Read display coordinates (9 high order bits only)
9. Clear flags

Not Available

### 330

1. Read display address counter
2. Skip on edge flag
3. Display resume
4. Skip on stop flag

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5. Load display address counter (start display)
6. Skip on light pen flag
7. Read X coordinates
8. Read Y coordinates (read status 2 for high order X & Y bits)
9. Read push down pointer
10. Read status 1
11. Read status 2
12. Read status 3
13. Read status 4
14. Read status 5
15. Set push down pointer
16. Set initial conditions
17. Skip on slave light pen
18. Load break field, 6 pushbutton, stop display
19. Special options
20. Skip on manual interrupt

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