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To: NoteTaker Programmers

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Subject: Programming the Display Controller (CRT5027)

stored: <fairbairn>DisplayControllerProgramming.bravo

The display controller is normally programmed into one of two states: driving 525 line monitors (usually internal) and driving Alto style monitors. The proper programming information for these two modes is given below.

Summarizing the basic parameters:

Parameter	521 lines	853 lines
Bit clock	12 Mhz.	18 Mhz.
Bit time	83.3 ns.	55.55 ns
Line Time	64.0 usec.	39.555 ns
Bits/line	640	576
Active lines/frame	480	784

Address	Data/521	Data/853	What it does
140_H	01011111 ($5F_H$)	01010111 (57_H)	Horizontal line count register. Total characters/line $=N+1$. $N(521)=95$ $N(853)=87$
142_H	1 | 1110 | 010 ($F2_H$)	1 | 1001 | 111 (CF_H)	Interlace bit | horizontal sync width | Horizontal sync delay Interlace (521/853) $=1$ Width(521)$=14$ chars.x666.64ns$=9.33$ usec. Width(853)$=9$ chars. x 444.44ns$=4.0$ usec. Delay(521)$=2$ char. x 666.64ns.$=1.33$ us. Delay(853)$=7$ char. x 444.44ns$=3.11$ usec.
144_H	X | 1111 | 101 ($7D_H$)	X | 1101 | 100 ($6C_H$)	Scan lines/ data row $(N+1)$ | characters/data row

Scan lines (521) = 15
Scan lines (853) = 13

Chars(521) = 5 (implies 80)
Chars(853) = 4 (implies 72)
[Other pairs are 0:20; 1:32; 2:40; 3:64; 4:72; 5:80; 6:96; 7:132]

Addr	Value 1	Value 2	Description
146_H	00 | 011101 ($1D_H$)	00 | 110111 (37_H)	Skew bits | Data rows/frame(N+1)

Skew(521) = 0
Skew(853) = 0

Rows(521) = 29
Rows(853) = 55

| 148_H | 00000100 (04_H) | 10101010 (AA_H) | Scan lines/frame |

Scans(521) = (4x2)+513 = 521
Scans(853) = (170x2)+513 = 853

| $14A_H$ | 00010000 (10_H) | 00011010 ($1A_H$) | Vertical data start - number of raster lines delay after leading edge of vertical sync of vertical start position. |

Vstart(521) = 16
Vstart(853) = 26

| $14C_H$ | XX000000 (0_H) | XX000000 (0_H) | Last displayed data row |

Row(521) = 0
Row(853) = 0

$14E_H$	unsused	unsused	Processor self load
150_H	unsused	unsused	Read cursor line address
152_H	unsused	unsused	Read cursor character address
154_H	00000000 (00_H)	00000000 (00_H)	Reset timing chain to top left of page.
156_H	unsused	unsused	Up scroll
158_H	00000000 (00_H)	00000000 (00_H)	Load cursor character address
$15A_H$	00 | 011110 ($1E_H$)	XX111000 (38_H)	Load cursor row address (This is used to block the video when it gets to this value)

Block(521) = 30
Block(853) = 56

| $15C_H$ | 00000000 (00_H) | 00000000 (00_H) | Start timing chain |
| $15E_H$ | unsused | unsused | Non-processor self load |

In choosing new values for these parameters the following should be kept in mind.

1. The horizontal sync must come at a frequency compatible with the monitor being driven. ~~Standard line-rate monitors (525) expect 15.750 Khz. (63.5 usec. period)~~ and the Alto-style monitors expect 26.250 Khz (38.1 usec.). The line rate generated by the internal sync generator will be

Hsync=(horiz line count reg. +1) x (8 bits/char.) x (bit clock period)
Hsync(521)=(95+1) x (8 bits/char.) x (83.3 ns/bit)=64.0 usec.
Hsync(853)=(87+1) x (8 bits/char.) x (55.55 ns/bit)=39.1 usec.

2. The vertical sync period must be 33.33 msec./frame for all line rates

Vsync=Scan lines/frame x Hsync
Vsync(521)=521 x 64.0=33.344 msec.
Vsync(853)=853 x 39.1=33.352 msec.

3. You should be able to set the *Scan Lines/Data Row* to any value between 0 and 15 (1 and 16) but empirical evidence indicates this value should be 13 (14) or less when running with an 18 Mhz. bit clock. This value is multiplied by *Data Rows/Frame* to come up with the total number of active lines to be displayed.

The value for *Characters/Data Row* determines how many visible bits are displayed. The number of visible bits will be 8 x this value. You must insure that you allow enough time for horizontal blanking:

HorizBlank=(Horizontal Line Count-Characters/Data Row) x 8 x (bit clock period)

This value should be at least 7 usec. for Alto-style monitors and 10 usec. for standard line-rate models.

4. The *Data Rows/Frame* is a good parameter to adjust the vertical size of the display in increments of character rows (see #3 above). Modifying this value does not change the line or field rate but merely the number of *displayed* lines. This means that any scan lines beyond (Data Rows/Frame x Scan Lines/Data Row) will appear black.

5. *Vertical Data Start* is a good number to play with in order to move the displayed data vertically on the screen. As in #4, the number of total scan lines is not changed but the position of the displayed lines is changed. This parameter should have a minimum of about 10_H. You must insure that

(Scan Lines/Data Row) x (Data Rows/Frame) +(2 x Vertical Data Start) <Scan Lines/Frame

6. An alternate way to adjust the number of displayed lines is to set the *Cursor Row Address* to the data row which you want blanking to start on. The difference between this method and that in #4 is that the remainder of the scan lines are left white in this case, rather than being blanked to black. This method has the same effect of using less bit map and displaying fewer lines of text.

7. The *Last Displayed Data Row* has no useful effect on the display and should always be initialized to 0.

If all you want to do is reduce the number of displayed lines on the display and then center what's left, then use the following:

Data Rows/Frame=Desired # of lines/Scan Lines per Data Row
Vertical Data Start= (Scan Lines/Frame - (Data Rows/Frame x Scan Lines/Data Row))/4