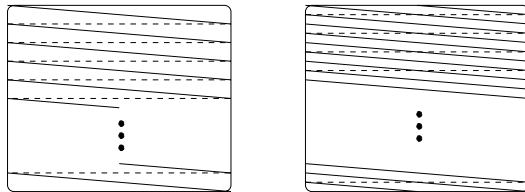


## 17.1 Video Displays

Monday, March 19, 2001

- Television and most computer displays use raster-scan.
  - We will always use non-interlaced formats.

Video (Raster-Scan) Displays are like Television



Non-Interlaced: Frame rate may be 60, 72, etc. frames/sec.

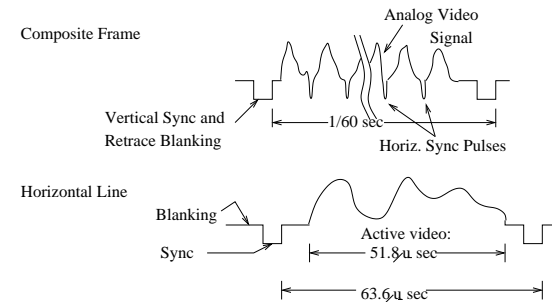
——— Scan line  
- - - - - Retrace line

Electron beam "scans" tube. Beam location is shown here. Beam current determines brightness of display.

Interlaced: Frames alternate. This is like television: 60 half frames/sec.

## 17.2 Composite Frames

- The 'frame' is a single picture (snapshot).
  - It is made up of many lines.
  - Each frame has a synchronizing pulse (Vertical Sync).
  - Each line has a synchronizing pulse (Horizontal Sync).
  - Brightness is represented by positive voltage.
  - Horizontal and Vertical intervals both have blanking.

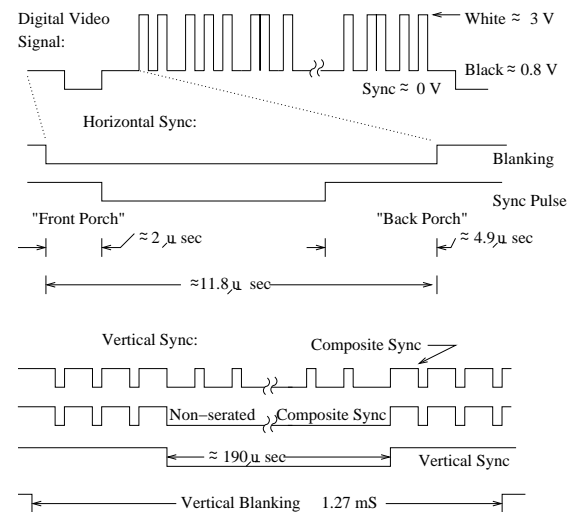


## 17.3 Synchronization

- Picture consists of white dots on a black screen.
  - White is positive.
  - Black is a low voltage.
  - Sync is below black.
- Sync pulses are in the middle of the blanking interval.
- Horizontal Sync coordinates lines.
- Vertical Sync coordinates frames.
  - Vertical sync is serated for commercial TV but need not be serated for local digital TV.
- Similar but for time scales
  - And they are superimposed on one another.

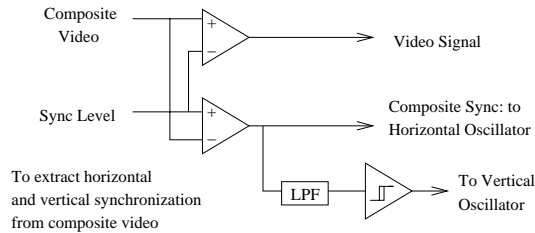
## 17.4 Composite Synchronization

These numbers are for television displays driven digitally.



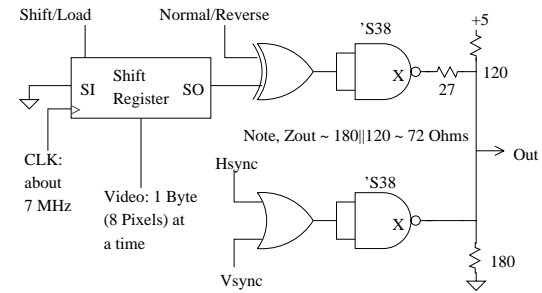
## 17.5 Recovery of Signals (Conceptual)

- Composite video has picture data and both syncs.
  - Video is above sync level.
  - Separation is easy.
- Sync is recovered by noting when composite is below sync level.
  - Horizontal sync is used directly.
  - Vertical sync is slower and is separated by a low pass filter and then squared up with a Schmitt Trigger.



## 17.6 Generation of Signals

- This is a simple way of building a front end
  - for the monochrome monitors in the lab.
  - Assume 1 bit per pixel.
  - Timing about right for TV style displays.
  - 'S38 is fast open collector part.

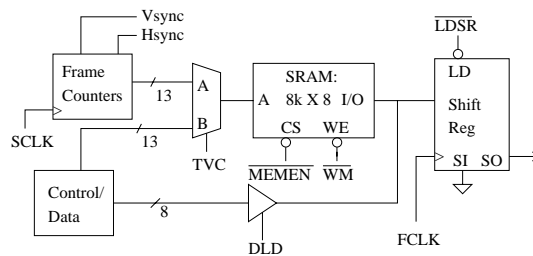


Here is a simple video "Front End" to produce a composite, binary, white-on-black or black-on-white signal that is one bit deep.

## 17.7 Control

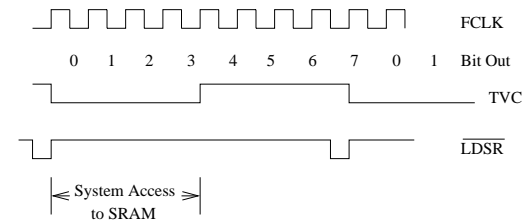
- Here is one possible display format.

- 256 pixels/row by 192 rows
- 7.16 MHz clock ==> .13966 microseconds/pixel
- Display time = 35.8 microseconds (active line)
- 256 X 192 = 49,152 = 48K pixels = 6K bytes



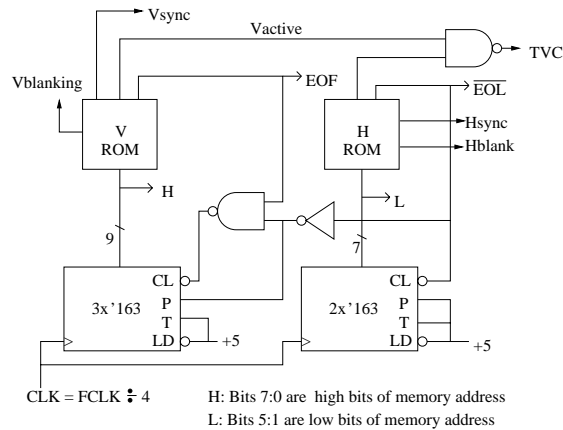
## 17.8 Timing of Control Signals

- Frame Counters and ROM produce sync signals.
  - FCLK is at pixel rate.
  - SCLK is FCLK/4.
- TVC controls picture memory access.
- LDSR controls loading shift register.
- DLD controls system access to picture memory.



## 17.9 Generation of Control Signals

Here is a scheme for generating the necessary control signals:  
Store information in ROMs (yet another use for them!).



## 17.10 ROM Contents

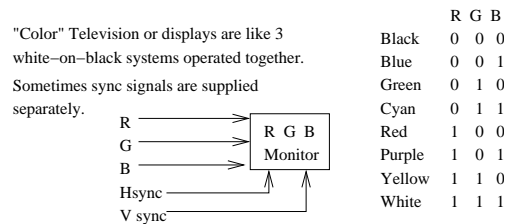
Reminder - our display format is:

256 pixels/row by 192 rows  
7.16 MHz clock ==> .13966 microseconds/pixel  
Display time = 35.8 microseconds (active line)  
256 x 192 = 49,152 = 48K pixels = 6K bytes

Vertical PROM:	Number of Locations	Addresses	Contents
	192	0 - 191	Vactive
	26	192 - 217	Vblanking
	6	218 - 223	Vsync
	37	224 - 260	Vblanking
	1	261	EOF
Horizontal PROM:			
	32	0 - 31	Hactive
	9	32 - 40	Hblanking
	7	41 - 47	Hsync
	8	48 - 55	Hblanking
	1	56	EOL

## 17.11 Color Displays

- Are similar to 3 black and white displays.
  - Colors add.
  - 3 binary video signals yield an 8-color display.
  - More colors are possible with more bits.
  - Some monitors have an analog video input for each color.
- Sync is often carried separately.
  - Sometimes sync is on the green video line.



## 17.12 Character Displays

- Characters are fixed bit patterns - have the same shape.
  - Can appear at different places on the screen.
- Letters and numbers are characters.
  - But other patterns can be useful.
  - E.g., a bullet moving up can be implemented by selecting from multiple characters. The rate of selection updates determine the velocity of the bullet.
- On a 256 column by 192 row screen:

Char Size	Rows	Columns	Chars/Page
8 x 16	12	32	384
8 x 12	16	32	512

Different character sizes are possible.

- Use of Characters can save video memory.
  - Need only specify which character rather than the bits in a character.

