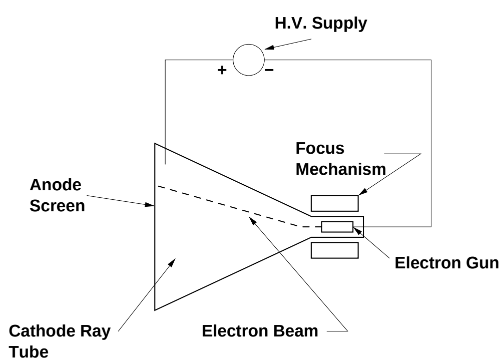
Video

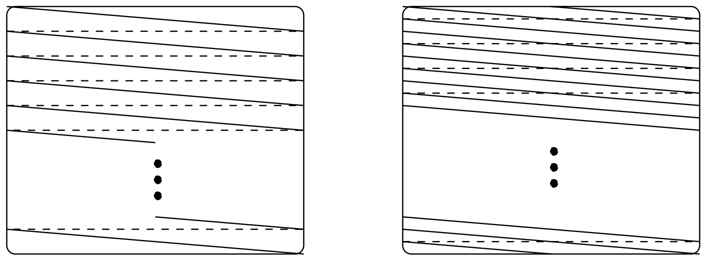
Video Displays

- Video displays are implemented by mirrors, LCDs, and CRTs.
- In a CRT (the displays in our laboratory)
  electron beams are focused on a small spot on the screen.
  The energy delivered to a phosphor causes a dot (pixel) to glow.
  - The beam can be moved rapidly in two dimensions.
  - The beam current determines the brightness of the spot.



Raster Scan

- Television and most computer displays use raster scan.



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

——— Scan line

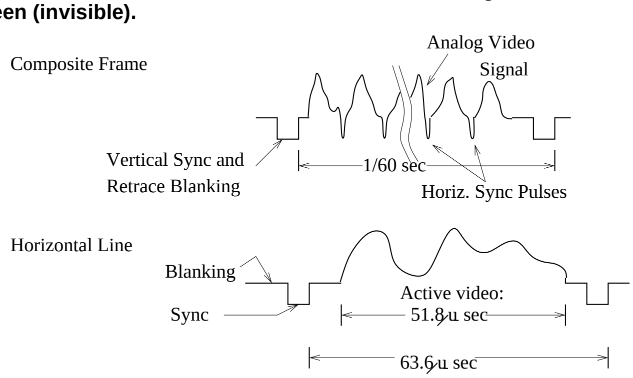
- - - - - - Retrace line

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

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

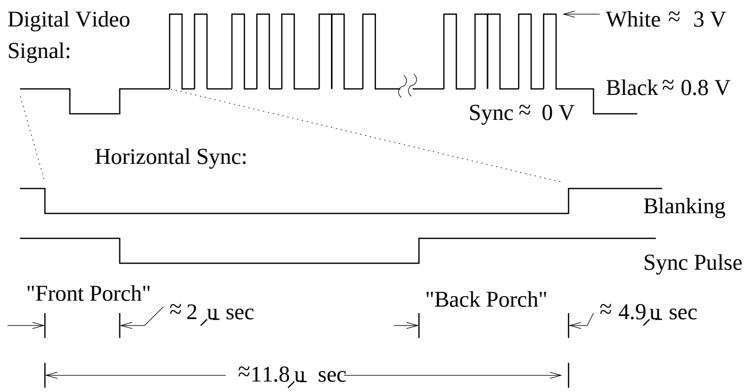
Composite Frames

- **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 a positive voltage.
  - Horizontal and Vertical intervals both have blanking so that retraces are not seen (invisible).



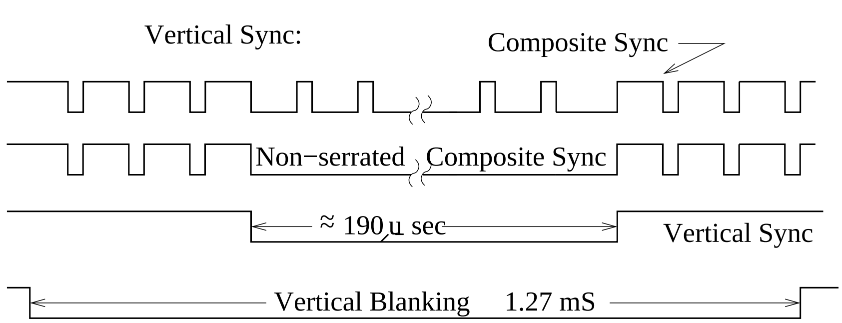
Synchronization

- The picture consists of white dots on a black screen.
  - White is the highest voltage.
  - Black is a low voltage.
  - Sync is below the black voltage.
- Sync pulses are surrounded by the blanking interval so one doesn't see the retrace.



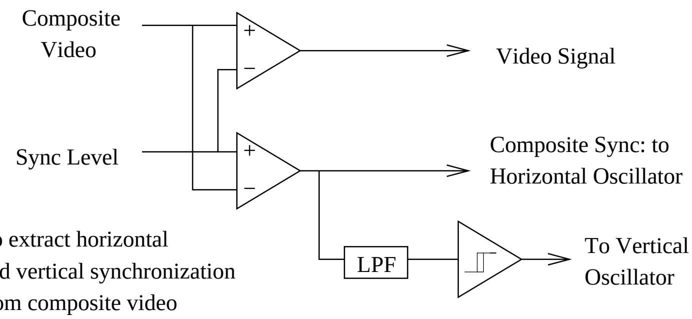
Composite Synchronization

- Horizontal sync coordinates lines.
- Vertical sync coordinates frames.
- They are similar except for the time scales and they are superimposed on each other. The numbers are for TV-like displays.
  - What purpose is there for serrated sync?



(Conceptual) Recovery of Signals

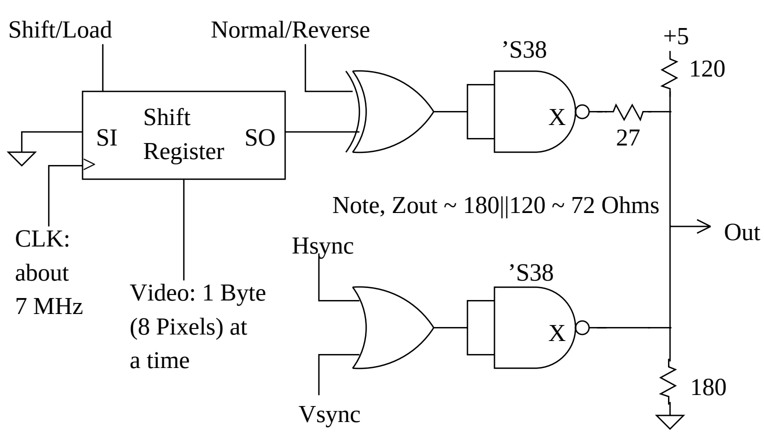
- Composite video has picture data and both syncs.
  - Picture data (video) is above the sync level.
  - Simple comparators extract video and composite sync.
- Composite sync is fed directly to the horizontal oscillator.
- A low-pass filter is used to separate the vertical sync.
  - The edges of the low-passed vertical sync are squared up by a Schmidt trigger.



To extract horizontal and vertical synchronization from composite video

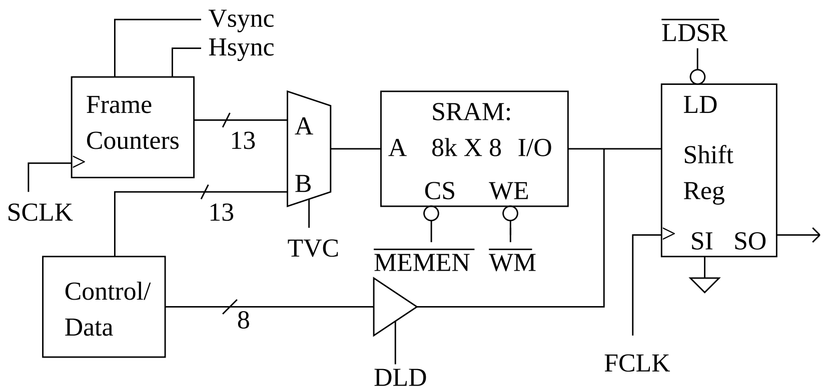
Generation of Signals

- Assume one bit per pixel and provide for reverse video.
- This is a simple ‘D/A’ to generate monochrome signals.
  - The ‘S38 is an open collector part so the voltages are determined by the resistor network. The output resistance is ~ 75 ohms.



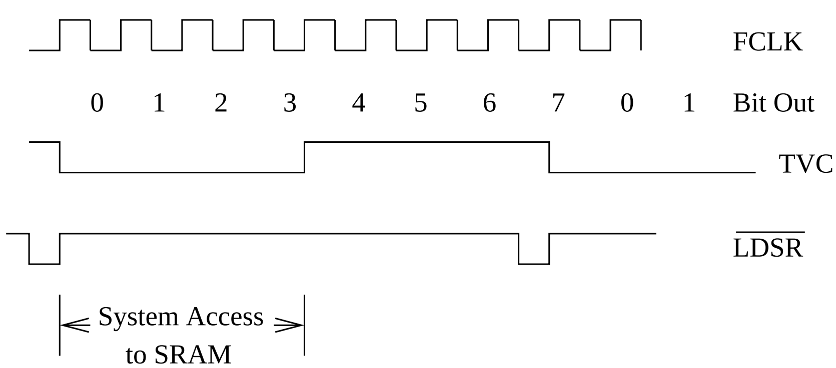
Control

- **Here is one possible display format.**
  - **256 pixels X 192 rows**
  - **7.16 MHz clock => 140 nanoseconds per pixel**
  - **Display time for the active line is 35.8 microseconds.**
  - **256 X 192 = 49,152 = 48K pixels = 6 K bytes**



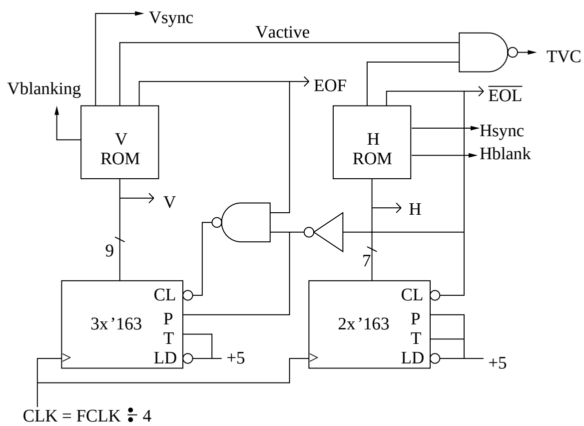
Timing of Control Signals

- **Data is loaded into a shift register and shifted out to generate the video signal.**
  - **FCLK is at the pixel rate.**
  - **TVC divides access to the SRAM giving half the time to get data to load into the shift register .**



Generation of Control Signals

- Here is one way to generate control signals
  - by storing information in ROMs to generate sync signals, TVC, and /EOL.
  - Note that EOL cause a line count and /EOL clears the dot counter.
  - And that (EOF AND EOL) causes a clear of the line counter.



ROM Contents for Control

- **Vertical Rom**

Number of words	Addresses	Contents
192	0 – 191	Vactive
26	192 – 217	Vblanking
6	218 – 223	Vsync
37	224 – 260	Vblanking
1	261	EOF

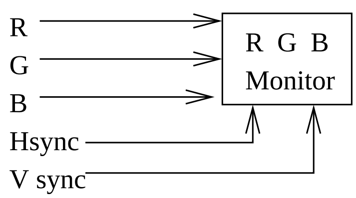
- **Horizontal ROM**

Number of words	Addresses	Contents
32	0 - 31	Hactive
9	32 - 40	Hblanking
7	41 - 47	Hsync
8	48 - 55	Hblanking
1	56	EOL

- **Whoops! Make sure the EOL bit is negative true.**

Color Displays

- **Color displays are similar to three monochrome displays operated together, i.e., the colors add.**
- **Three binary signals yield an eight-color display.**
  - **Some monitors have an analog video input for each color.**
- **Sync is sometimes on a separate wire.**
  - **Sometimes it is superimposed on the green signal.**

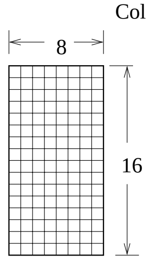


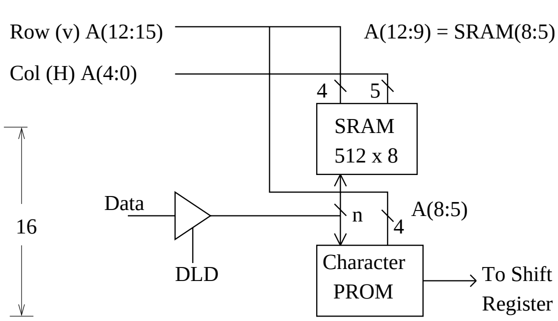
	R	G	B
Black	0	0	0
Blue	0	0	1
Green	0	1	0
Cyan	0	1	1
Red	1	0	0
Purple	1	0	1
Yellow	1	1	0
White	1	1	1

Character Display (8 x 16 pixels)

- **Characters are fixed bit patterns.**
  - **They always have the same shape but can appear at different places on the screen.**
  - **Use of characters can save video memory and make the manipulation of video memory contents simpler.**

For a screen 256 x 192 one gets 384 characters. The screen address is used to specify the position and part of the address of the character ROM

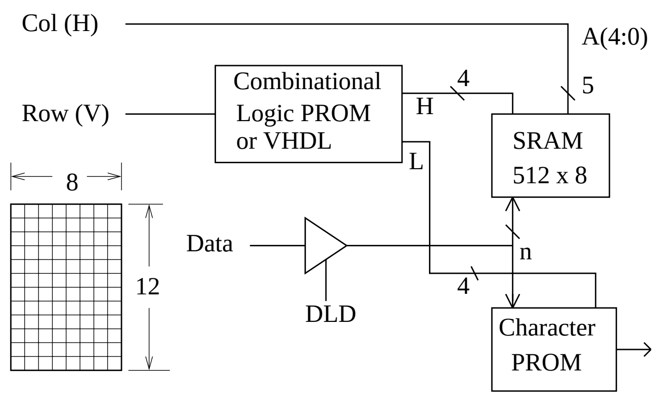




Character Displays (8 x 12 pixels)

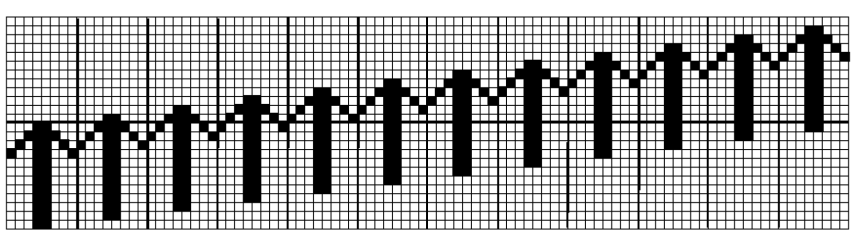
- Row formatting is not as simple as before.
  - But remapping is easily done in a prom or VHDL.

For a screen 256 x 192 one gets 512 characters. The screen address modified by combinational logic is used to specify the position and part of the address of the character ROM



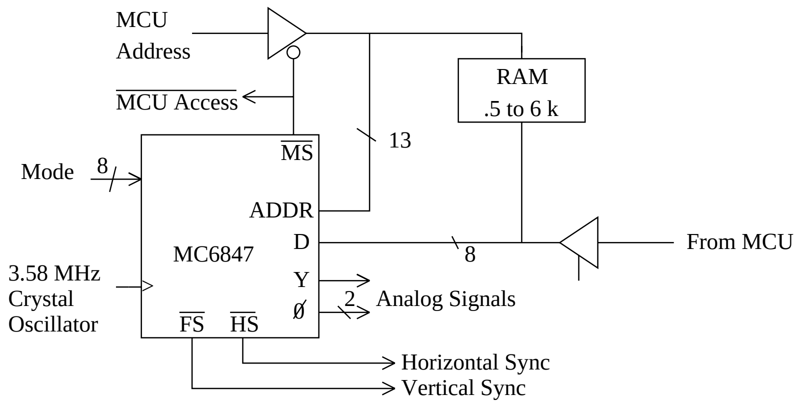
Pairs of Characters

- Sometimes, pairs of characters can create the same motion effect as bit-mapped graphics.
  - The speed of the motion depends on the update rate.
- These 24 characters (12 x 2) can display an arrow at any vertical position.



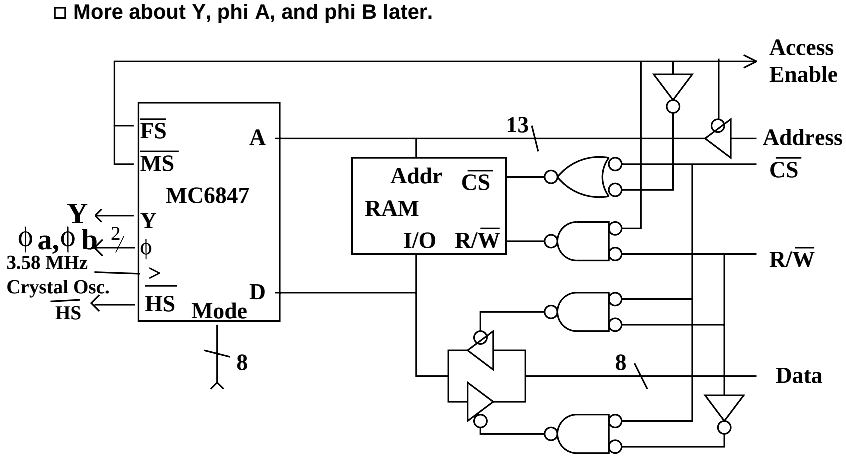
Video Controllers

- MC6847 is obsolete but easy to use.
  - It provides a 13-bit address and an analog video signal.
  - It reads 8-bit data which can be either a character code or video data.
  - Several display modes include 256 x 192 two-color and several other color graphics modes with lower resolution.



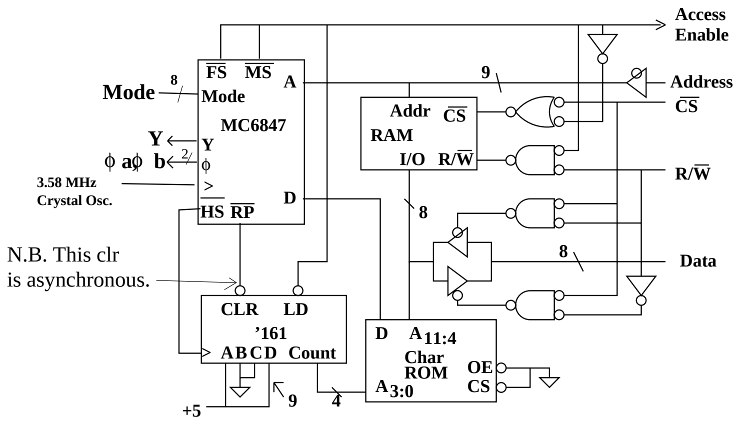
Bit-Mapped Video

- MC6847 can be used with bit-mapped video.
  - More about Y, phi A, and phi B later.



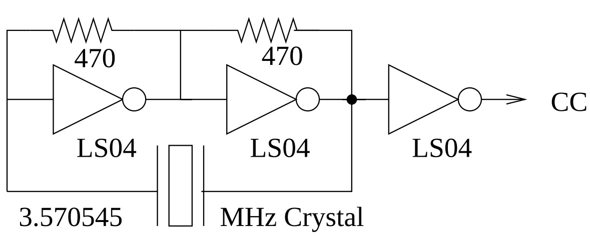
MC6947 With a Character ROM

- **You can call it a bug or a feature!**
  - **To get around the fact that /RP begins and ends between /HS pulses, one must use a counter that has an asynchronous clear, similar to the '161. Of course, one can implement this counter with VHDL but one has to remember to implement an asynchronous clear.**



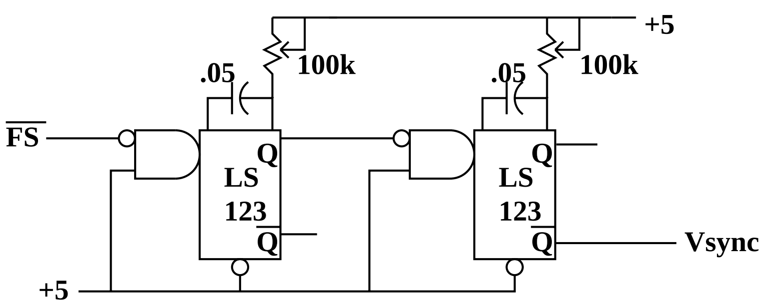
Supplying a Clock

- **The MC6847 is meant to be run by a color-burst crystal oscillator.**
- **The recommended circuit is to use a pair of LS04 inverters. to provide the gain for an oscillator.**



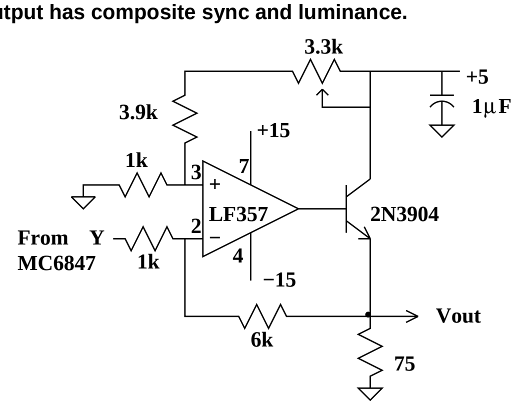
Centering the Display

- The MC6847 generates blanking, not vertical sync.
- You have to generate vertical sync.
  - ◻ You can do this digitally with counters.
  - ◻ Alternatively, one can use two one-shots.
    - The first one-shot triggers on the falling edge of /FS and determines the delay of Vsync.
    - The second one-shot determines the width of Vsync.
    - Adjust the pots so that the picture is centered on the monitor.



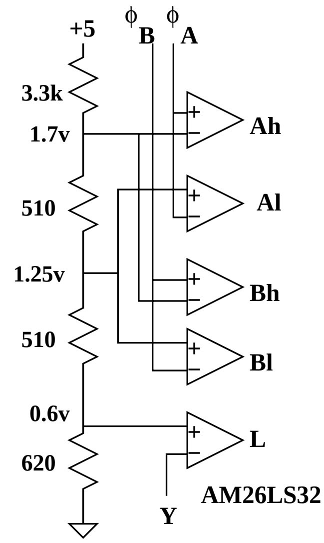
Drive a Monitor

- Use a 75 ohm coax cable to connect to the monitor.
  - ◻ Remember to terminate the monitor with 75 ohms.
    - There is usually a switch on the back of the monitor.
- Here is a simple way to drive a monochrome monitor.
  - ◻ Don’t make the gain of the ‘357 too small or you will get some ringing.
  - ◻ The Y output has composite sync and luminance.



Color Output

- The first step is to convert the analog signals, phi A and phi B, to digital signals.
- The circuit on the right works for one of the color modes. It is not guaranteed to work for the mode you want to use!
  - In particular, the luminance signal may never be a one for your mode.
  - Display a test pattern and look at the analog signals with a scope.
- The resistor chain determines the voltages input to the comparators (as in a flash converter).
- The AM26LS32 is a “fast” comparator (it is actually a line receiver).

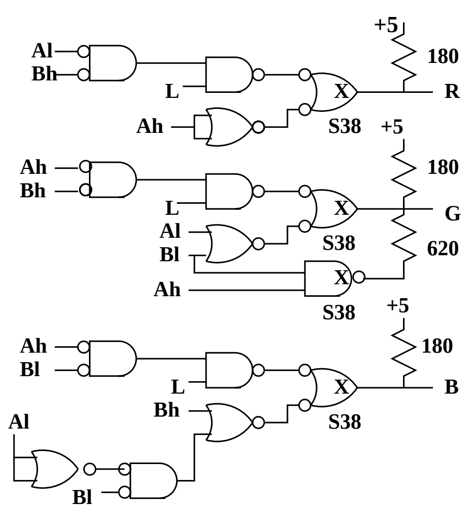


Coding to Get RGB

- This combinational logic can (should) be implemented in VHDL.
- The logic depends on the mode selected.
  - Look at the Ah, Al, Bh, Bl, and L outputs to determine the logic needed.
  - The 74S38 driving the 620 ohm resistor is one way to get orange.

```
An available cable pinout is:

Pin 1    Intensity
Pin 2    Red
Pin 3    Green
Pin 4    Blue
Pin 5    GND
Pin 6    GND
Pin 7    HSYNC
Pin 8    VSYNC
```



These Drive RGB Inputs