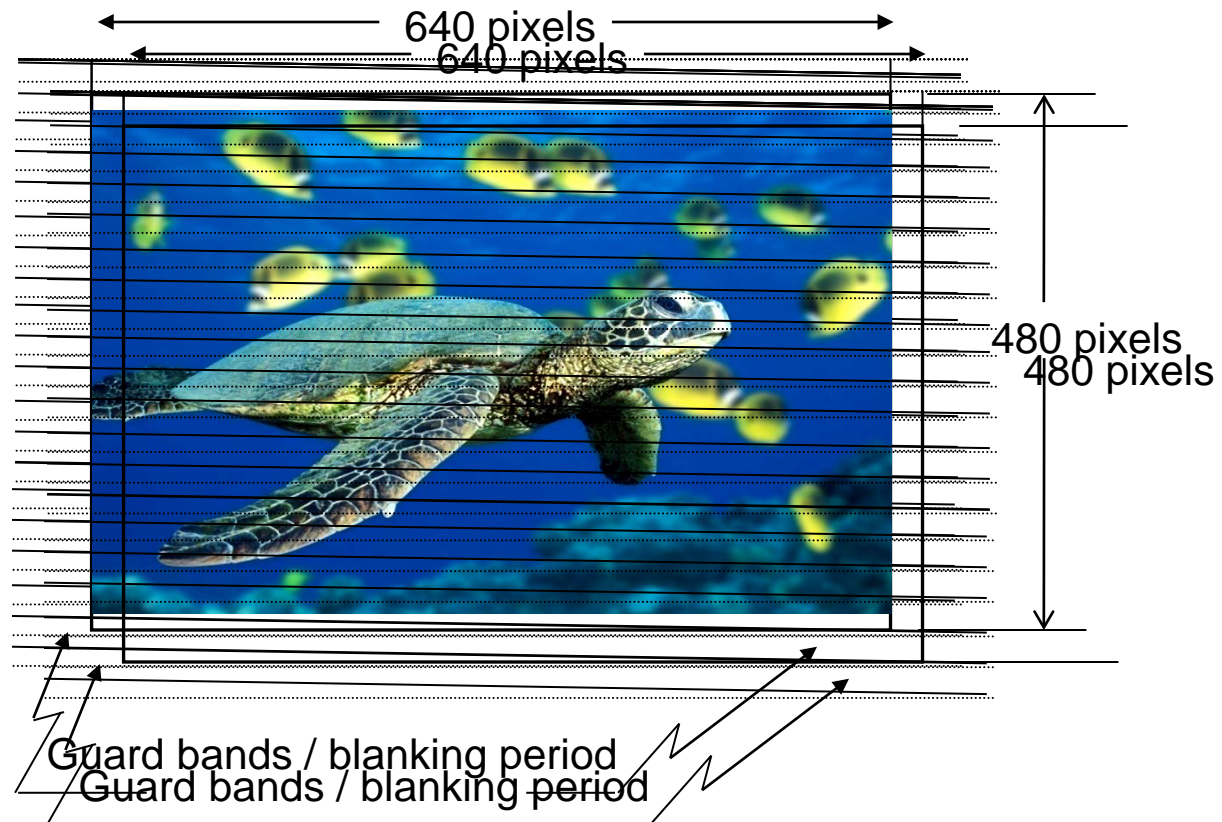

CSE 20221: Logic Design

VGA Monitor

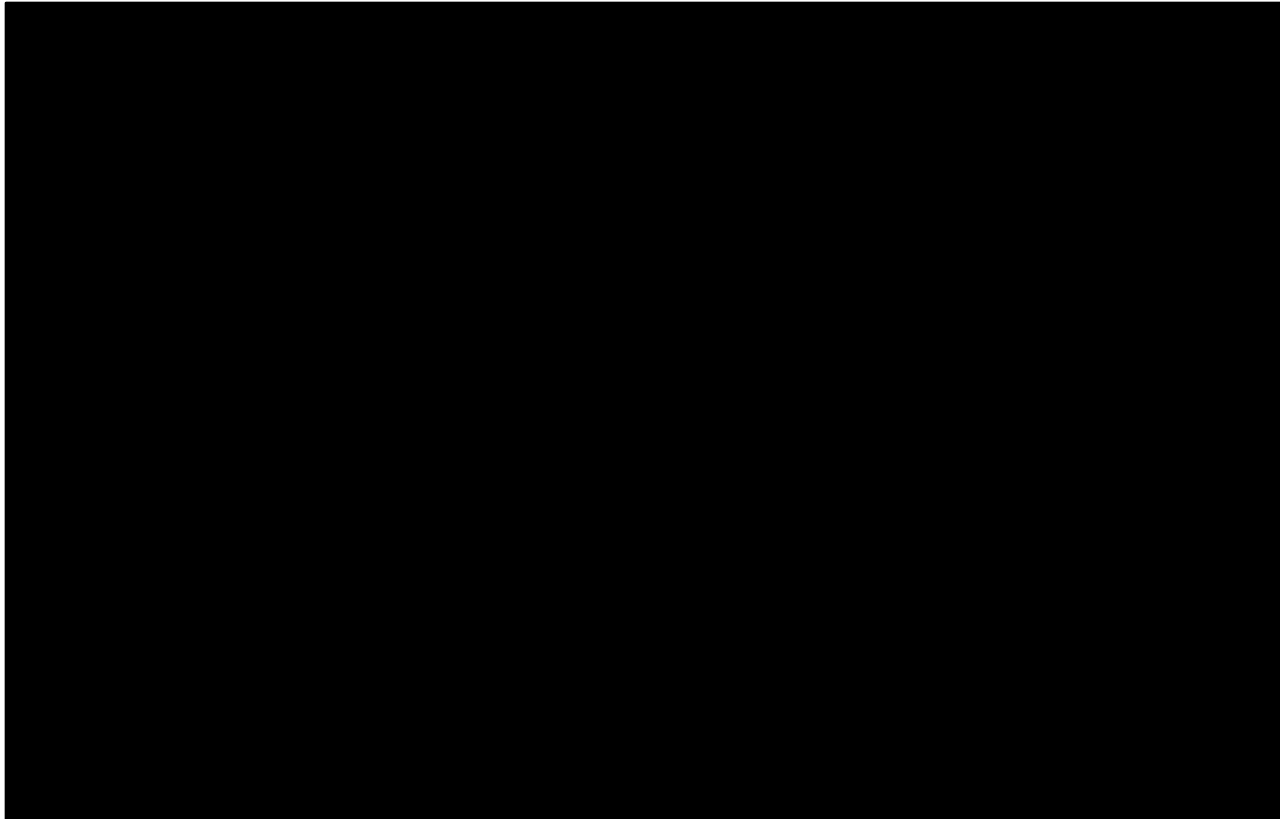
Interface to the Basys Board

VGA Scanning

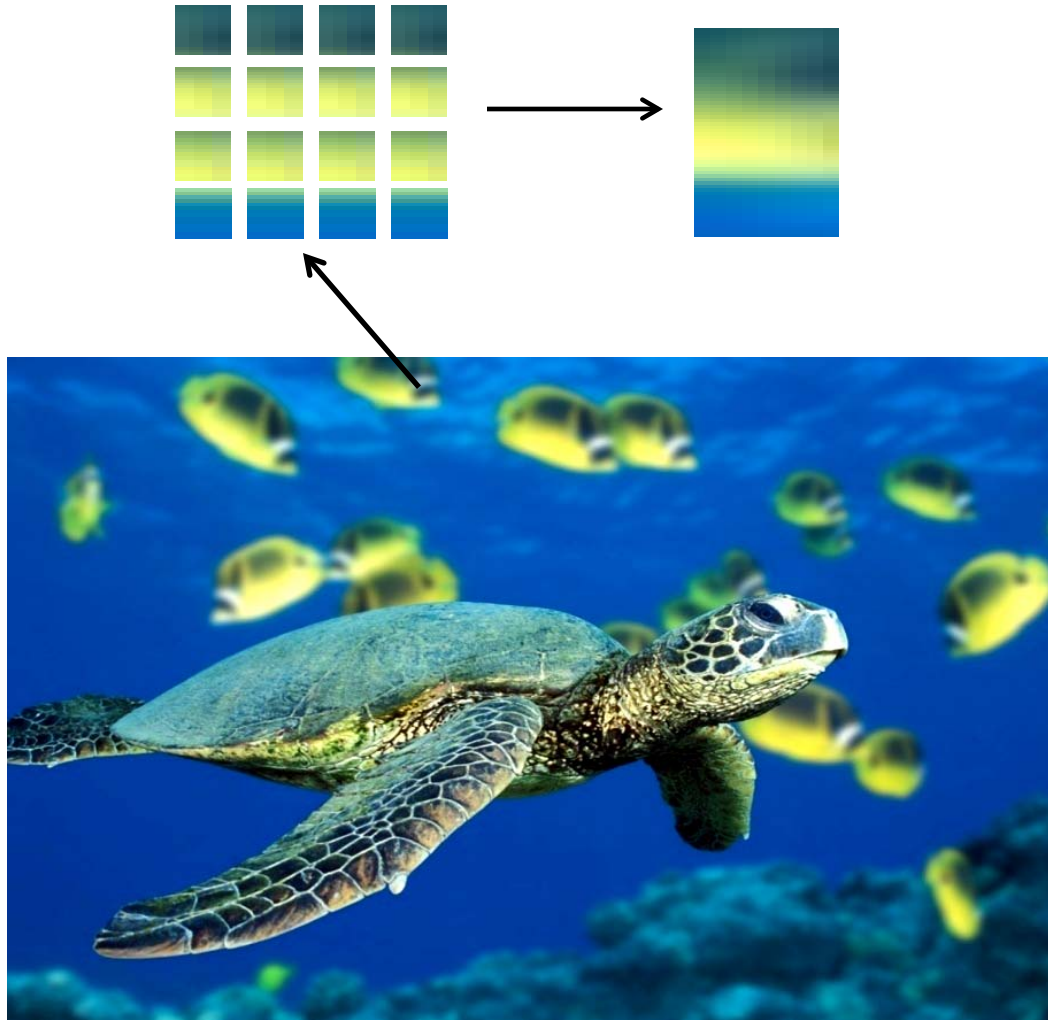
A standard VGA monitor consists of a grid of pixels that can be divided into rows and columns. Consider a VGA monitor containing 480 rows, with 640 pixels per row, as shown in the diagram below. A pixel is the smallest picture element. A pixel's properties include color and brightness.



VGA Scanning



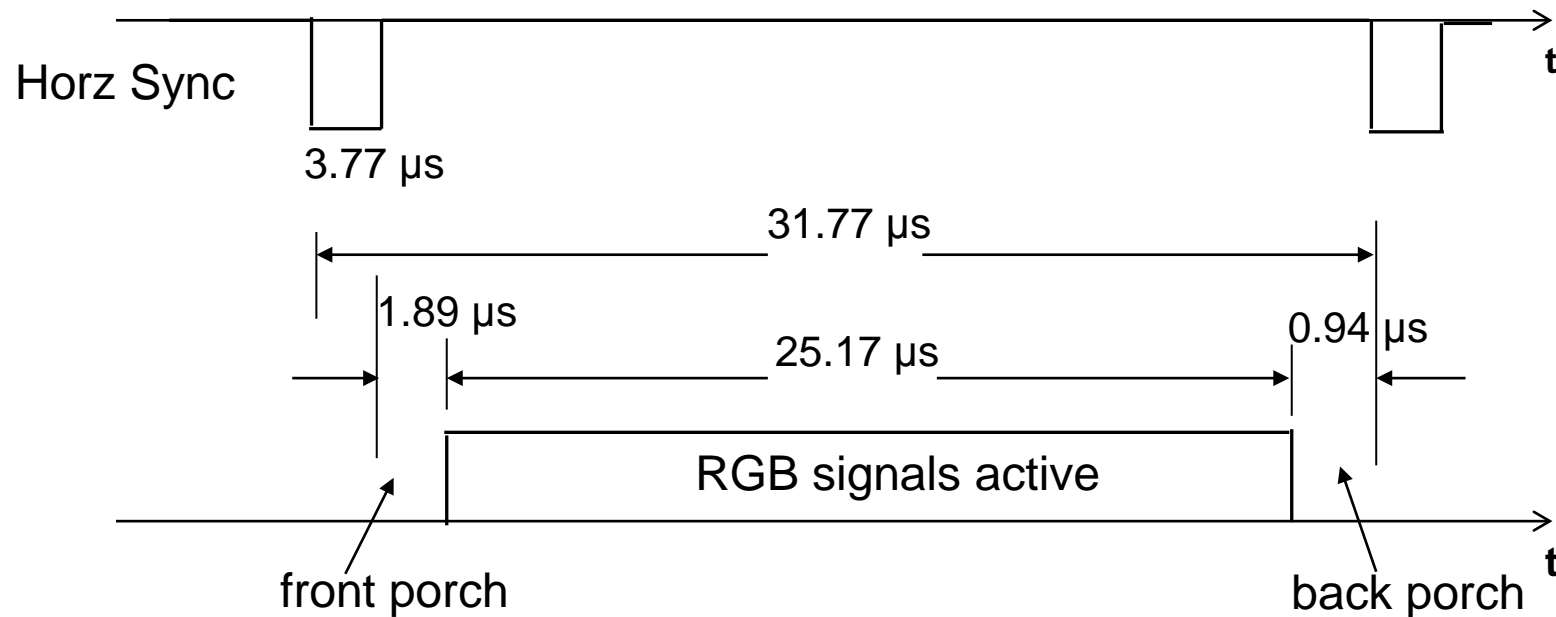
Pixel-by-Pixel



Horizontal Sync Pulse & , R, G, B Signals

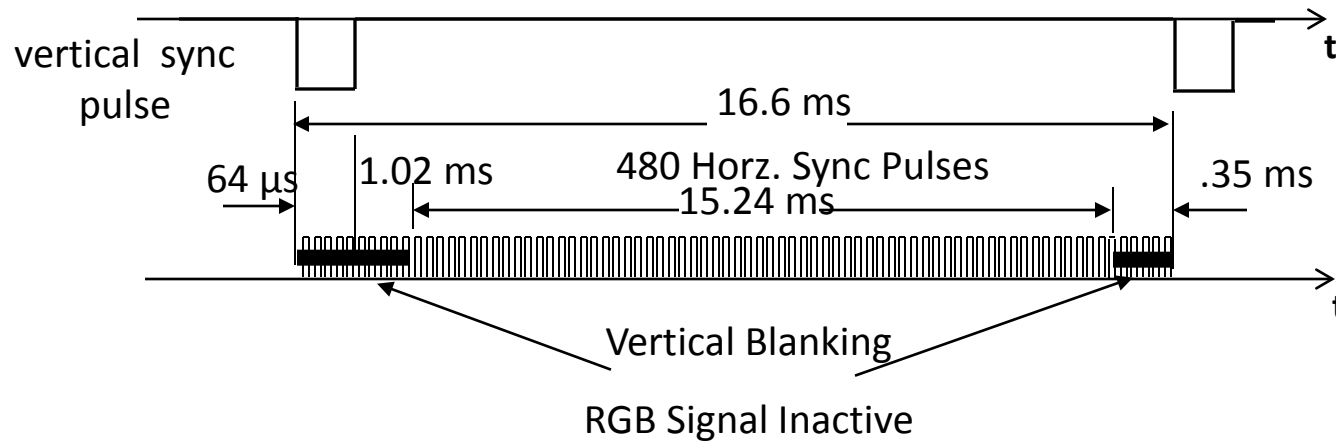
- Horizontal sync pulse triggers when to begin horizontal scan
- R (red), G(green), B(blue) determine the image color and brightness.
- R, G, and B are set for each pixel, one pixel at a time
- values for RGB depend on the location of the electron beam striking the phosphor on the screen.

Horizontal Timing Diagram



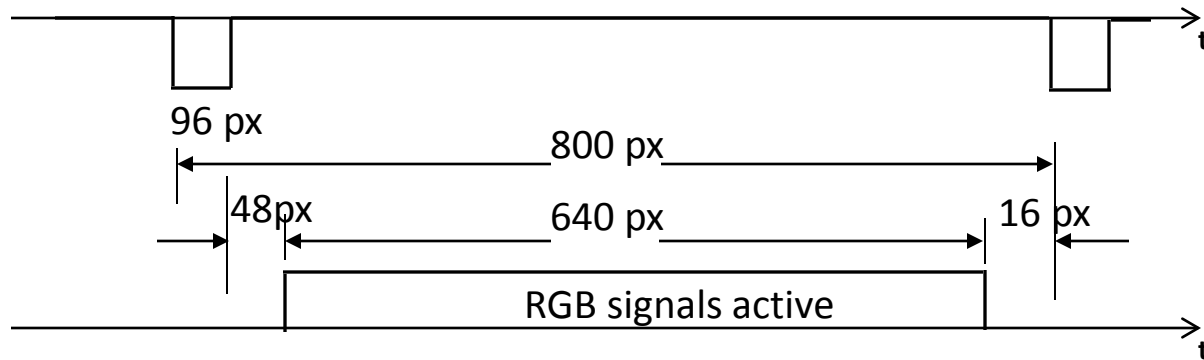
The above timing is based on the standard 25.175 MHz clock.
Refer to slide 10 for the Basys board clock rate of 25 MHz.

Vertical and Horiz. Sync Pulses



$$F_{\text{FRAME}} = 59.94 \text{ Hz, vertical sync frequency}$$

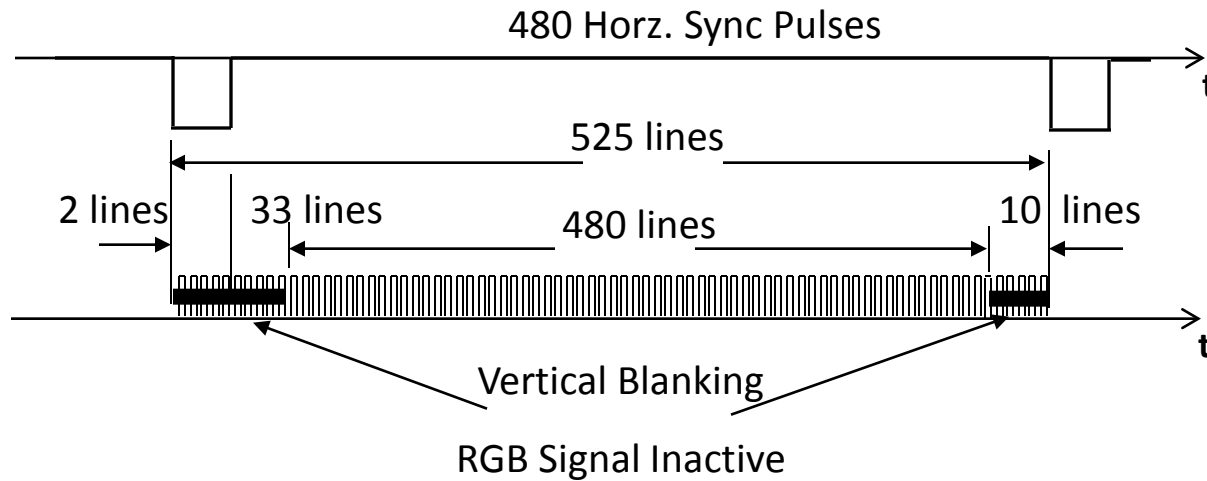
Horiz.Timing in Terms of Pixels



$$T_{\text{PIXEL}} = 1 / F_{\text{CLK}} \quad \text{Standard value for } F_{\text{CLK}} = 25.175 \text{ MHz}$$

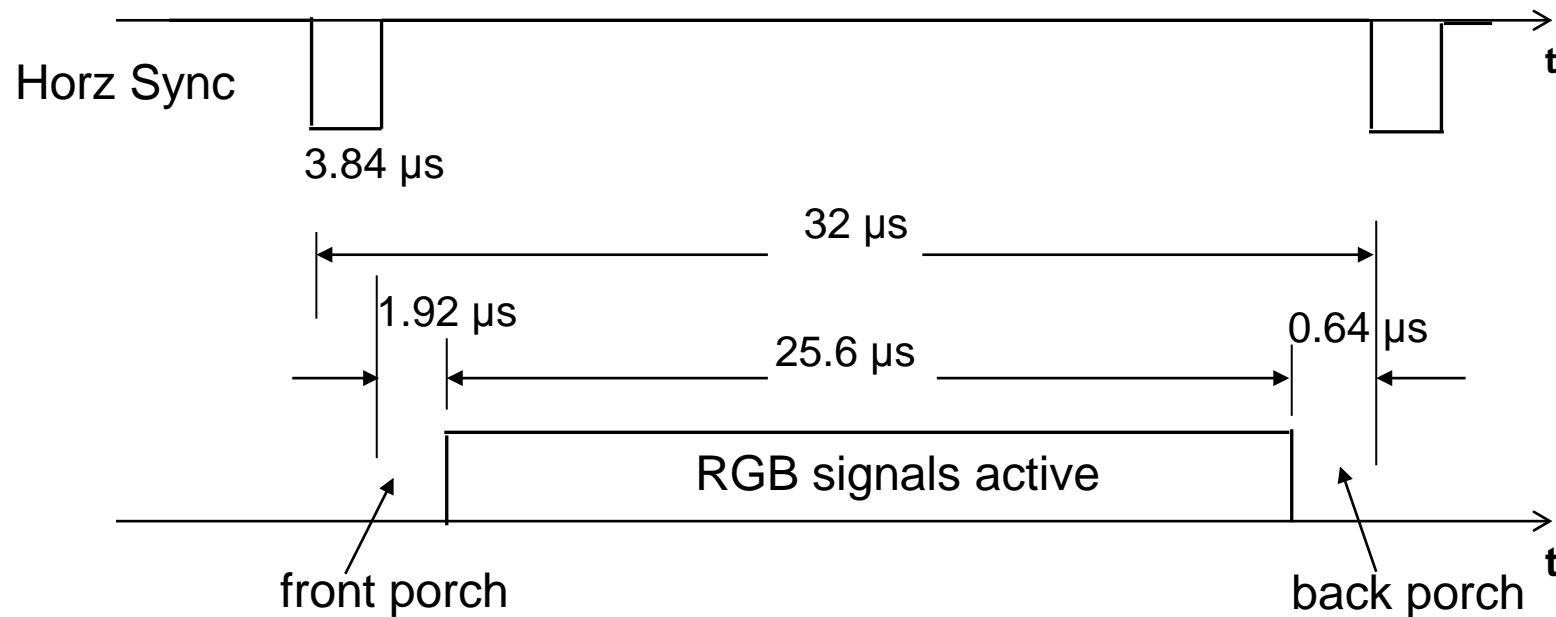
$$T_{\text{ROW}} = T_{\text{PIXEL}} * 640 + T_{\text{LEFT GUARD BAND}} + T_{\text{RIGHT GUARD BAND}}$$

Vertical Sync Relative to Horiz Sync pulse

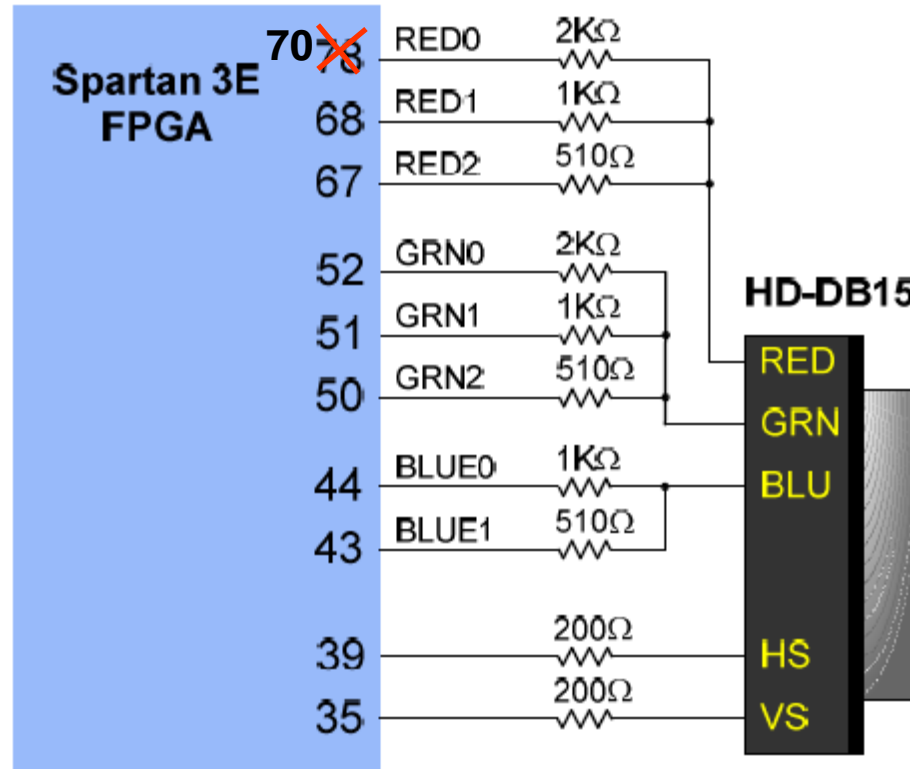


Horizontal Timing Diagram for Basys

The Basys board uses a 25MHz clock instead of the standard 25.175Mhz

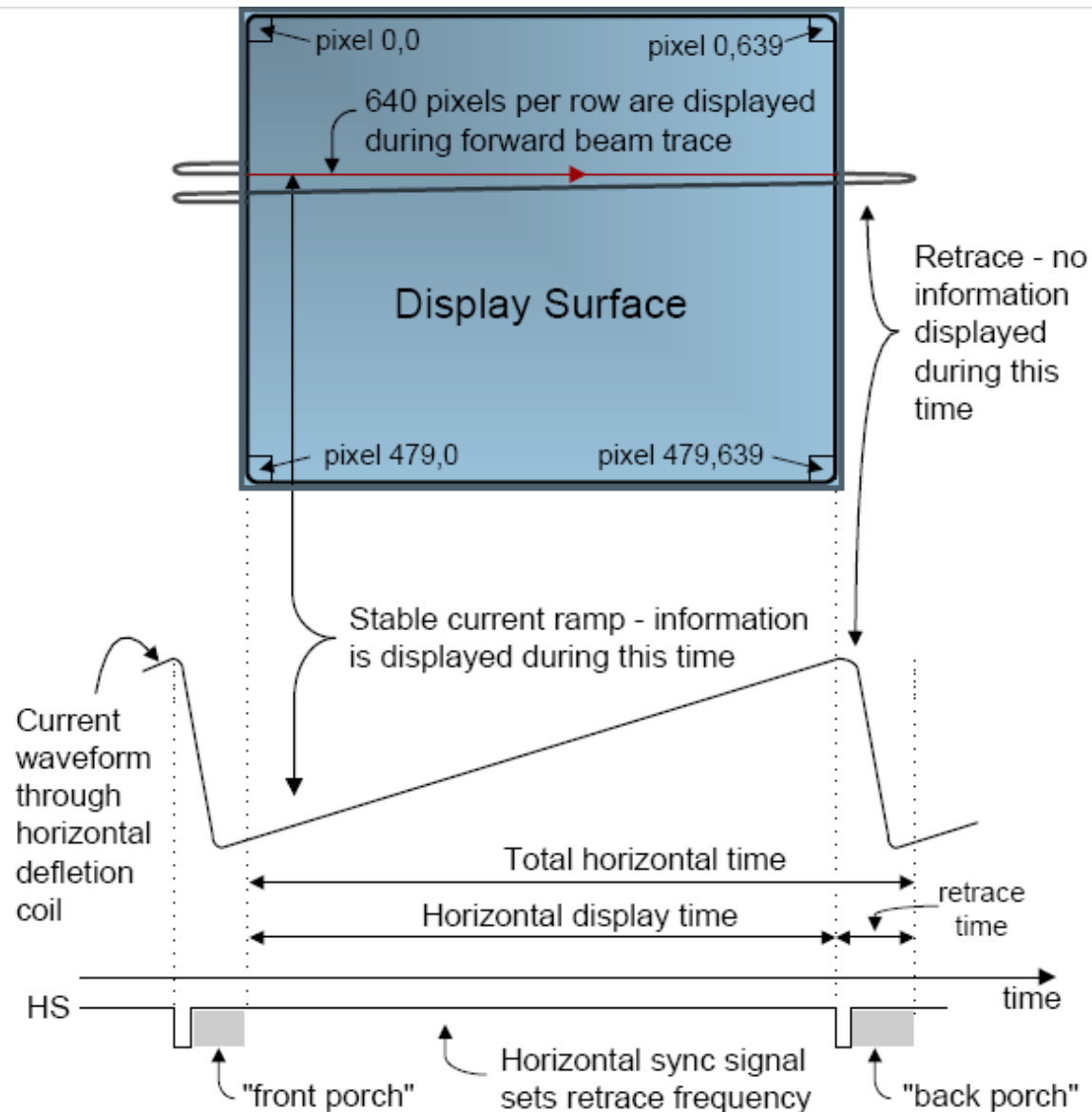


Basys Board



Red and Grn are 3-bit words – 8 levels of brightness, 000 to 111
Blue is 2-bit word – 4 levels of brightness
HS – horizontal sync pulse, VS – vertical sync pulse

VGA Signals



Block Diagram

