INTRODUCTION TO FPGA PROGRAMMING

Lesson 13a: Operating a VGA screen

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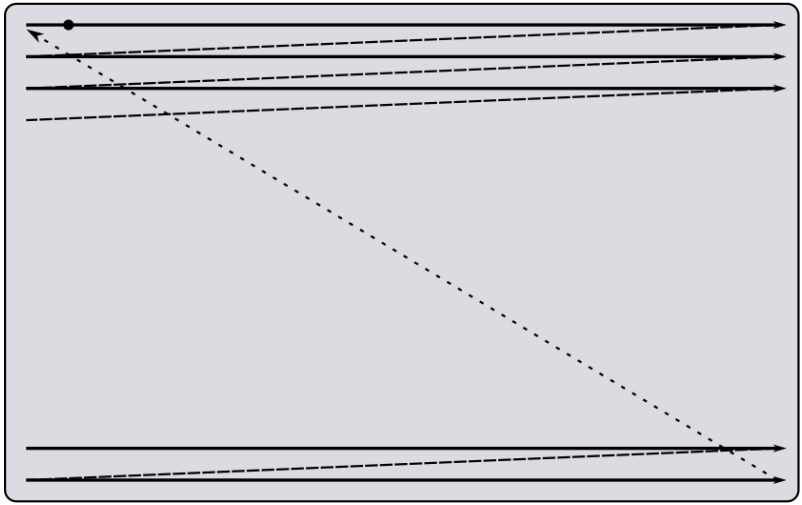
HOW A SCREEN WORKS

- A normal screen (LCD) is made of individual blocks of colours
  - Red, Green, Blue (RGB)
- The smallest part of the screen you can control is the pixel
  - 640x480 display has more than 300,000 pixels
- All pixels in a screen are refreshed with a fixed frequency, typically 60 Hz
- Different connectors available on the market, having similar data designs (VGA, HDMI, DP)

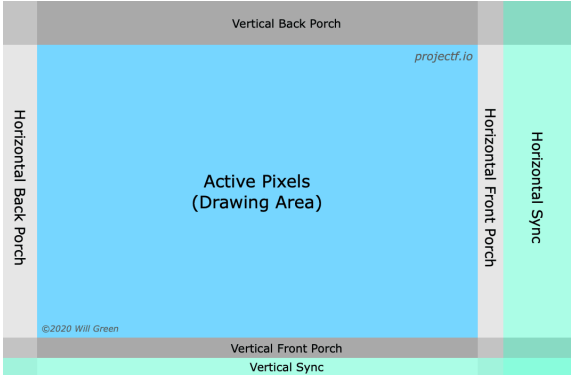
HOW A SCREEN WORKS

- Starting from the upper left corner, pixel's outputs are updated one after the other



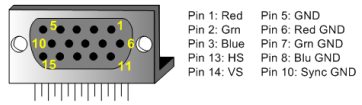
VGA SCREEN COMPONENTS

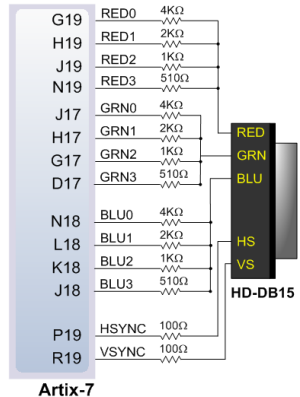
- **Active Video**: The time during which pixel data is transmitted and displayed on the screen.
- **Blanking Interval**: The period when no video signal is transmitted, used for synchronization and screen refresh.
  - Fundamental for old Cathode Ray Tube (CRT) screens, kept for compatibility in VGA
  - All screen parameters for the different resolution are available at here.



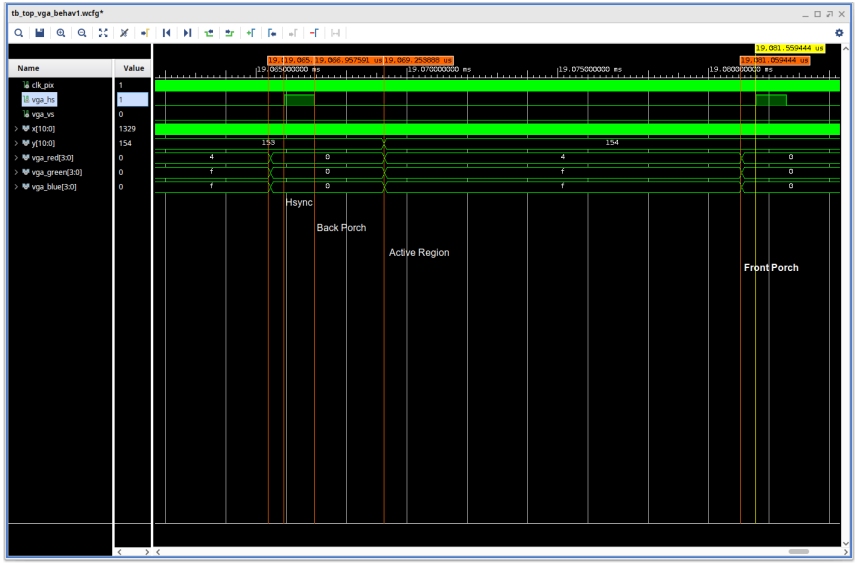
DRIVING A DISPLAY

- The VGA connector has separated lines for the Red, Green, Blue signals
  - With Basys-3 we have 4-bits for each colour -> 12-bit display
- There is no clock transmitted with the FPGA connector
- A new line in the screen is signaled with the HSYNC port
  - HSYNC must be active for the Horizontal Sync interval
- Screen moves to next frame, when VSYNC is active for the Vertical Sync Interval

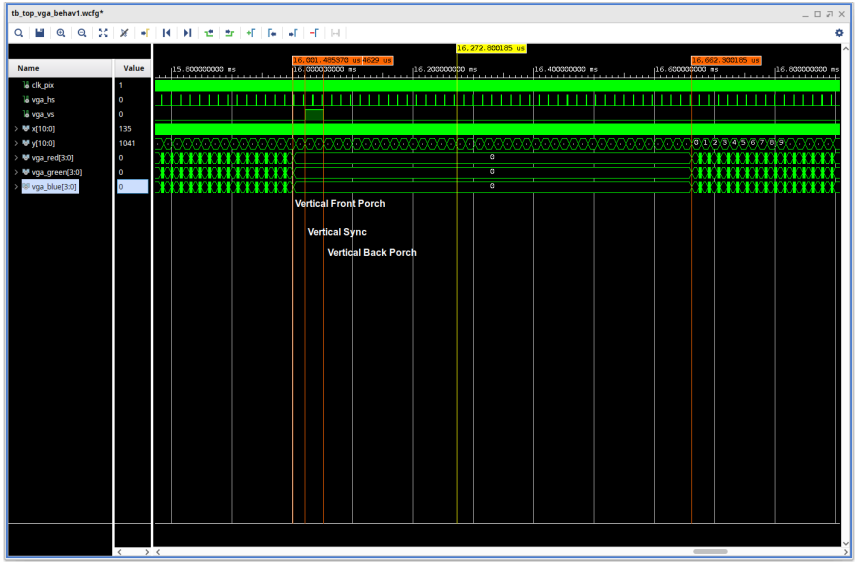




HORYZONTAL SYNCHRONIZATION



VERTICAL SYNCHRONIZATION



LAB 21: CONNECTING TO A VGA DISPLAY

The figures in these slides are taken from:

- Digital Design: Principles and Practices, Fourth Edition, John F. Wakerly, ISBN 0-13- 186389-4.

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