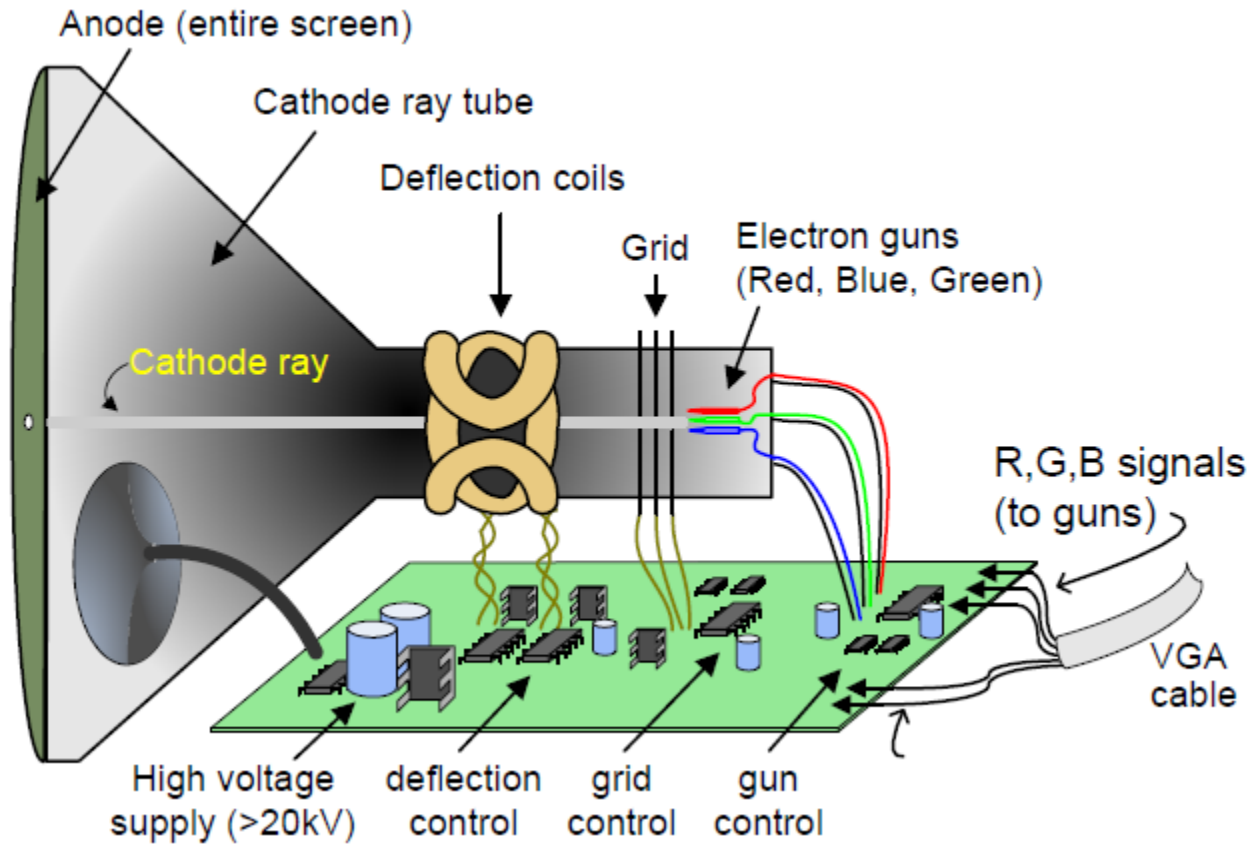
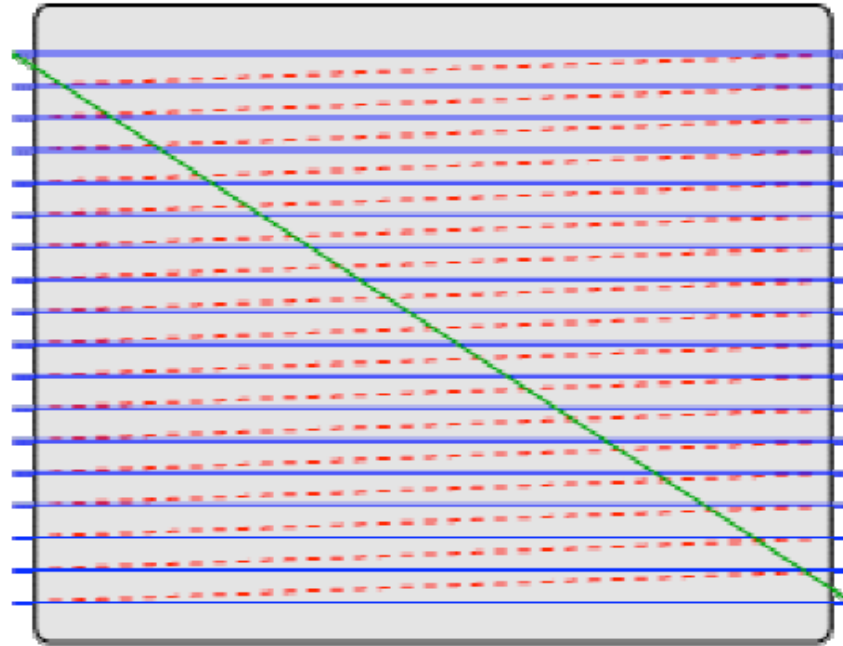


VGA controller

CRT screen



Drawing on a CRT screen



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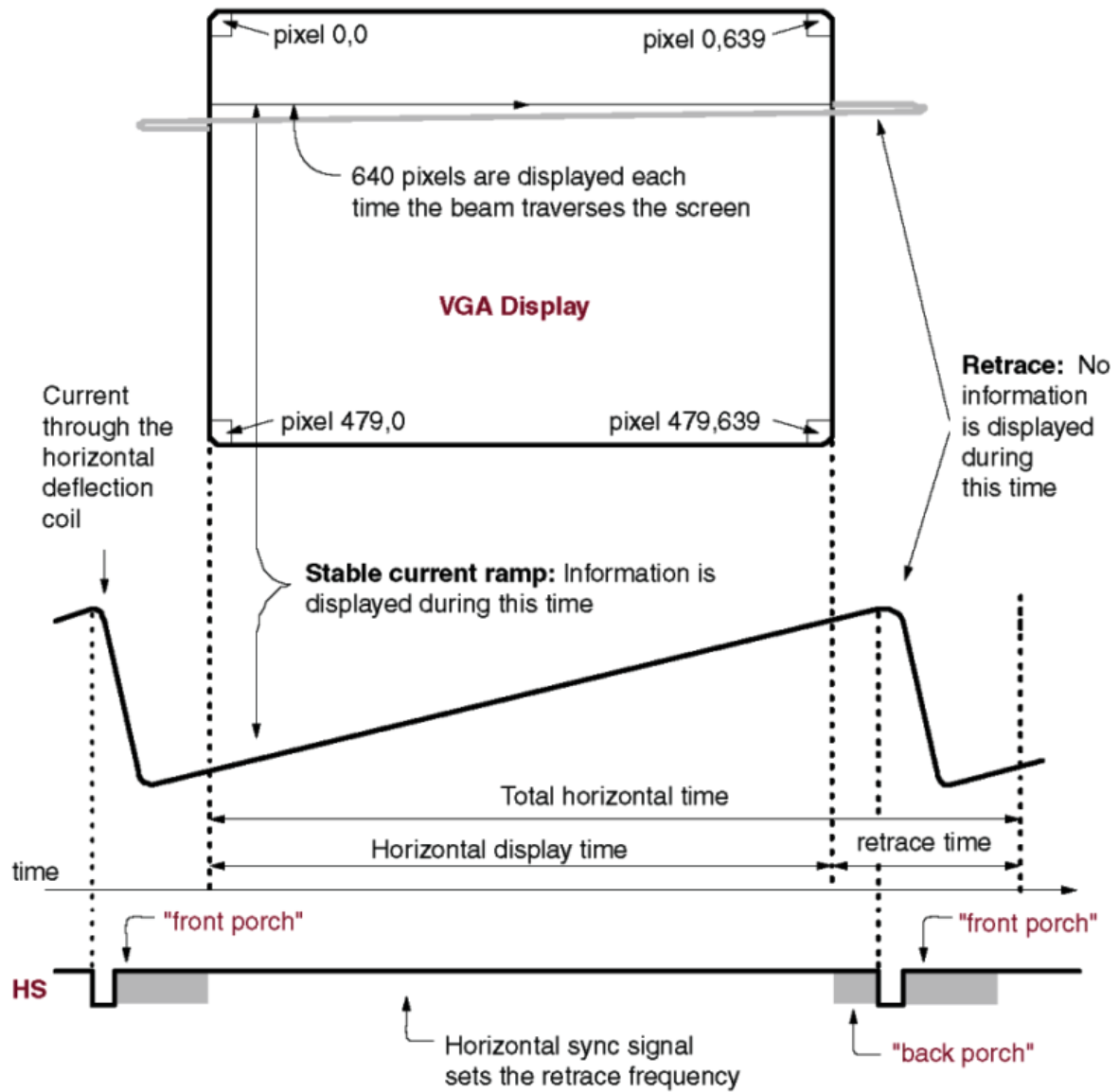
- Our eyes don't notice individual pixels drawing if the frequency is high enough
 $\geq 60\text{Hz}$

Signals

- RED, GREEN, BLUE
 - To define the color of the pixel
- HSYNC, VSYNC
 - Synchronization signals that define the current position

HSYNC

- The HSYNC signal defines if the current in the deflection coils is increased or decreased
 - Higher current -> the ray is deflected further right
- The impact of the HSYNC signal
 - $\text{HSYNC} = 1$ -> linear increase of the current
 - $\text{HSYNC} = 0$ -> decrease of the current



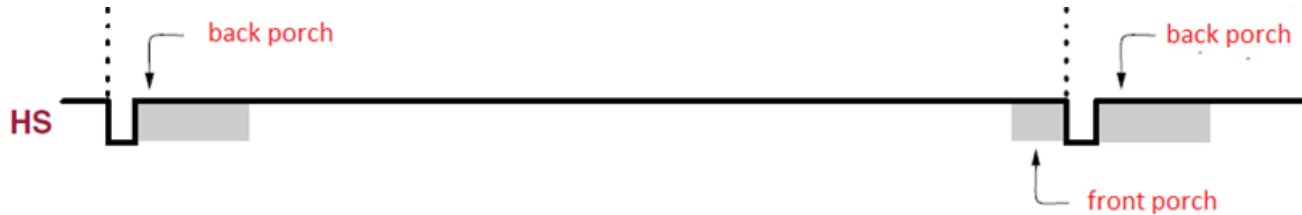
HSYNC signal

- display time
 - The beam is moving to the right and is inside the display limits
- sync pulse
 - The beam is returning to the left-most point
- back porch
 - The beam is moving to the right and is to the left of the display
- front porch
 - The beam is moving to the right and is to the right of the display

- We will draw the pixels with 25Mhz
 - Period = 40ns
- the durations for each part of the signal are defined in the standard
- The duration can differ to some degree for some manufacturers
- Example for the 640x480 resolution:

Frame part	Part duration[num. of cycl.]
Sync pulse (SP)	96
Front porch (FP)	48
Back porch (BP)	16
Display time (DT)	640

HSYNC modul



- Scan time (ST) = SP + BP + FP + DT
 - 800 clock cycles in our case
- Create a counter that counts from 0 to (ST -1)
- Based on the counter set
 - HSYNC
 - 0, when in SP, 1, otherwise
 - HVIDON
 - 1, when in display time, 0, otherwise
 - COLUMN
 - In the display area output the column number (0 do 639)
 - ROWCLK
 - Impulse at ST-1

Naloga

- Create the HSYNC module
 - inputs
 - CLK, RESET
 - outputs
 - HSYNC, COLUMN, ROWCLK, HVIDON

Nexys4 signals

- 12 bits to define the color
 - red 4, green 4, blue 4

