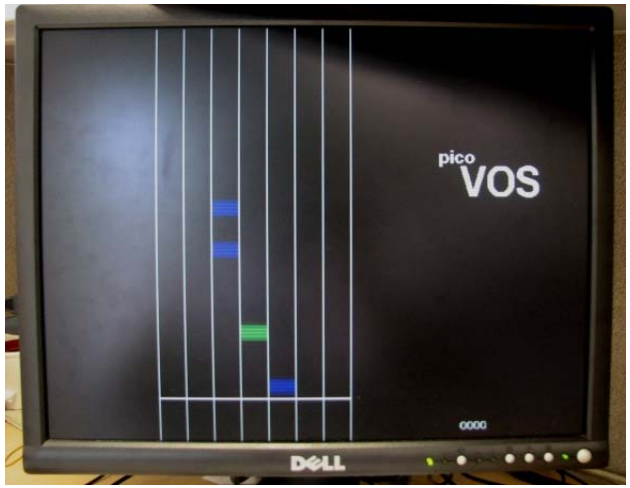
Spartan®-3AN FPGA Starter Kit picoVOS Demo

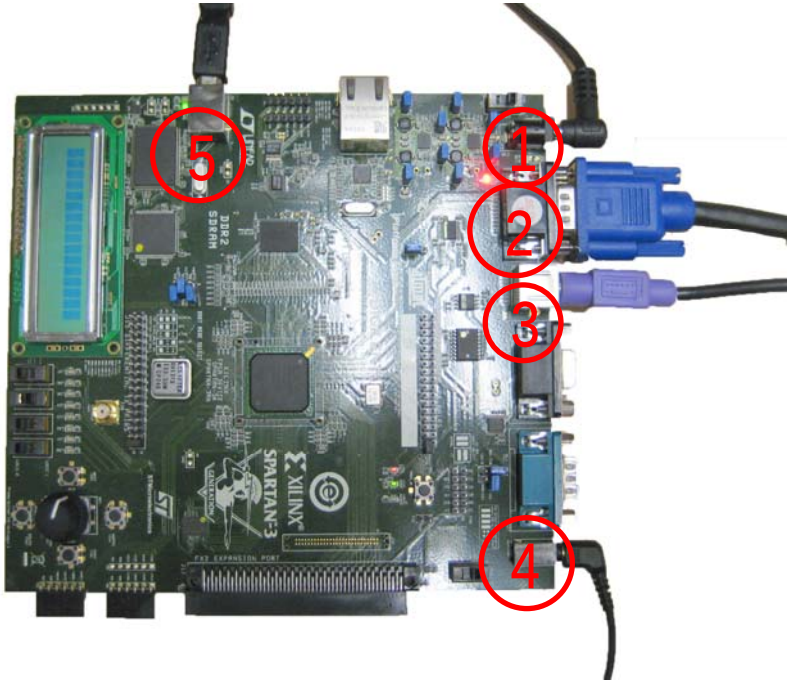
What is picoVOS

- **picoVOS is a video game clone of VOS (Virtual Orchestra Studio)**
- **The players hit keyboard keys when the color block drops to the horizon line**
- **Every key hit produces a sound**
  - It will become music if keys are hit correctly



Fast Demo Setup

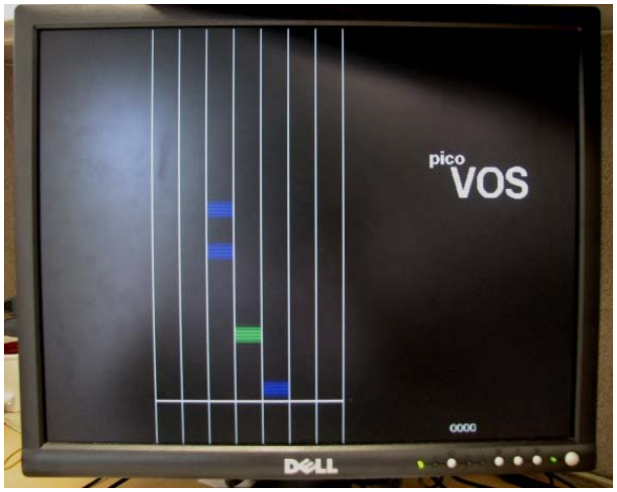
1. Make sure power switch is turned off, then connect power supply to board
2. Connect suitable display device to VGA port
3. Connect PS/2 keyboard
4. Connect 3.5mm earphone or speaker
5. Connect USB cable
6. Double click “demo/quick_demo.bat” to configure FPGA



picoVOS Usage

- Hit keys when color blocks drop to the horizon line
- 7 keyboard hitting keys:

A	S	D	SPACE	K	L	;



- Score:
  HIT = 2, Cool = 4, Miss = 0

  - ESC to restart
  - Up/Down to adjust the dropping speed

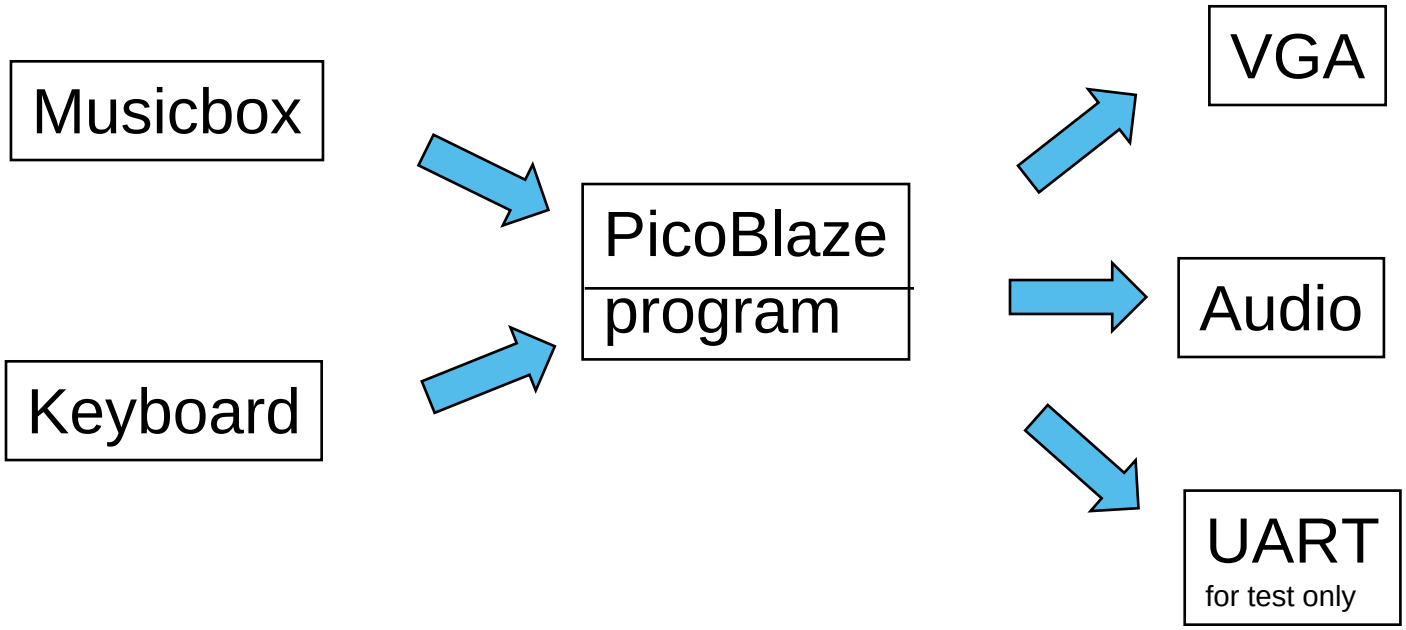
Project Rebuild

- Download PicoBlaze™ processor source code from www.xilinx.com/picoblaze
- Copy kcpsm3.v, uart_tx.v and kcuart_tx.v, bbfifo_16x8.v from the PicoBlaze package into “source” directory
- Windows user: double click `run.bat`
  Linux user:

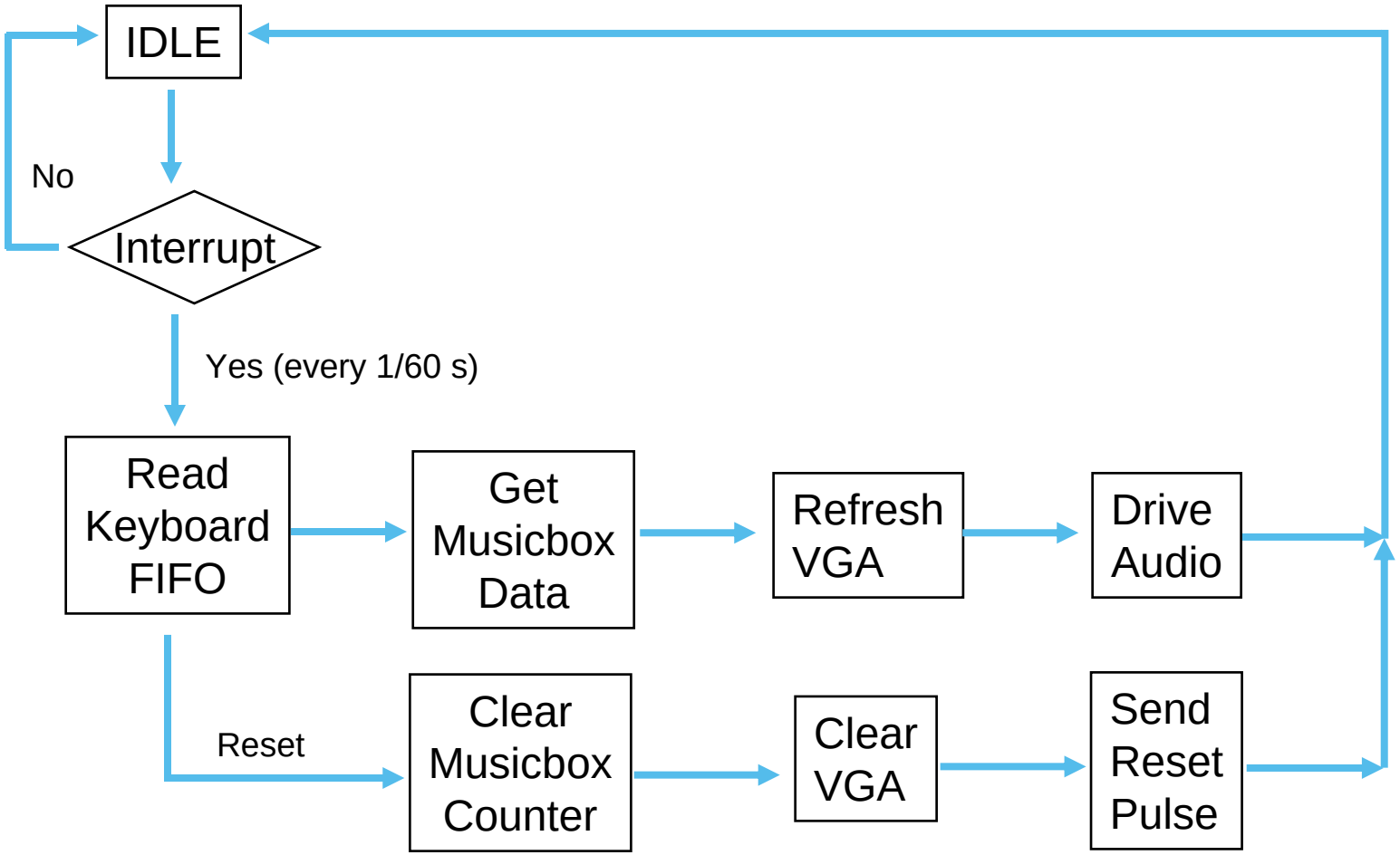
```
source <ISE_INSTALL_DIR>/settings.sh
chmod +x run.sh
./run.sh
```

- The script will generate the ISE project, implement, generate the final bit file in work directory and download the bit file into FPGA

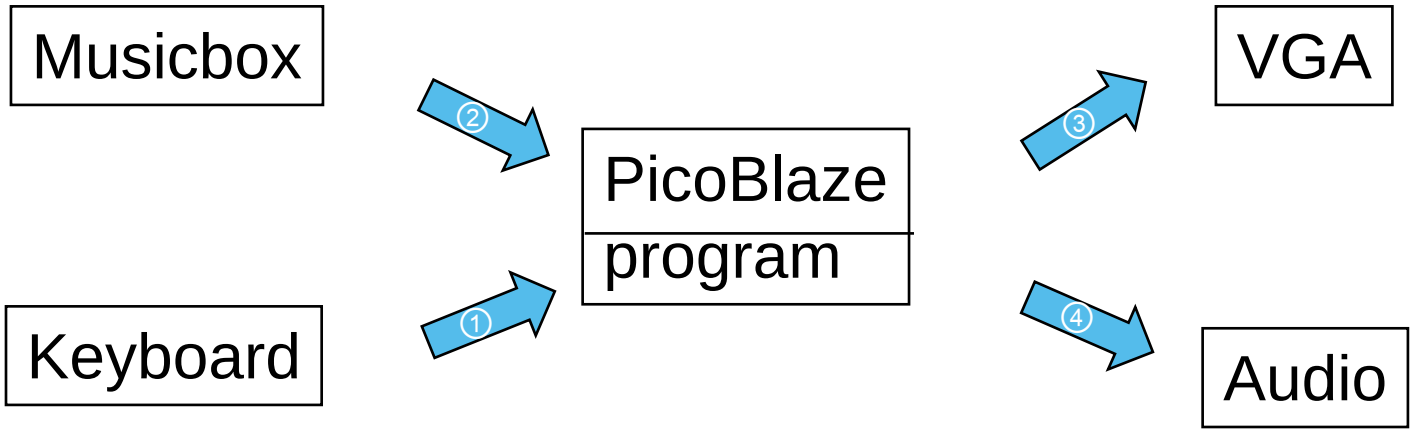
Project Hardware Structure



Project Software Diagram



Hardware + Software



1. **Read keyboard FIFO**
2. **Get Musicbox data**
3. **Refresh VGA**
4. **Drive Audio**

Demo Tech Details

- **PicoBlaze™ processor evaluates user inputs and controls peripherals**
- **Frame buffer for LOW COST usage**
- **Reusable peripherals**
  - PS/2 Keyboard receiver
  - VGA driver

Tech: PicoBlaze

- **This module was obtained from the Xilinx website, http://www.xilinx.com/picoblaze and is not included in the source download**
- **The primary function of PicoBlaze processor is to process the motion of display contents**
  - Demo program is stored in a single Block RAM
  - Excellent “programmed” alternative to an FSM

Tech: Save Block RAM

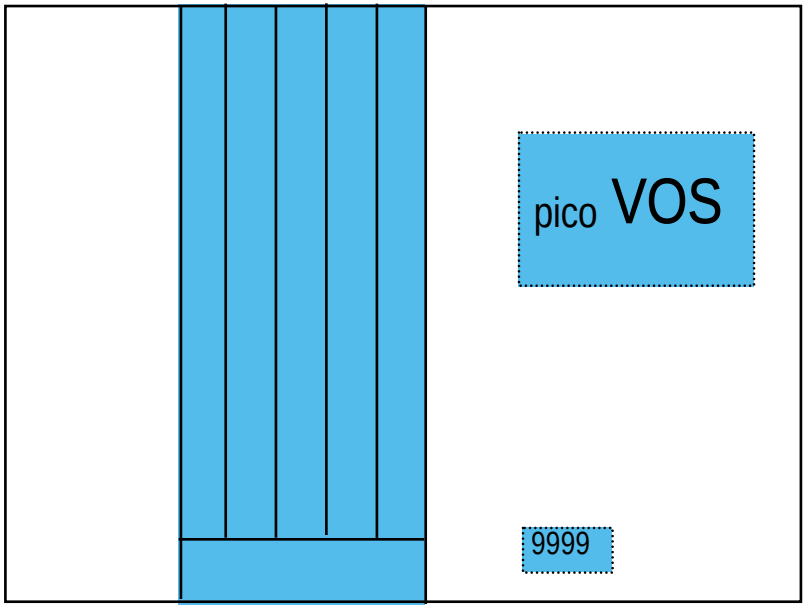
- 640x480 full screen 8 colors frame buffer needs Block RAM:

$$\frac{640 \times 480 \times 3}{18 \times 1024} = 50$$

- XC3S700A Block RAM resource: 20
- picoVOS design Block RAM utilization: 7

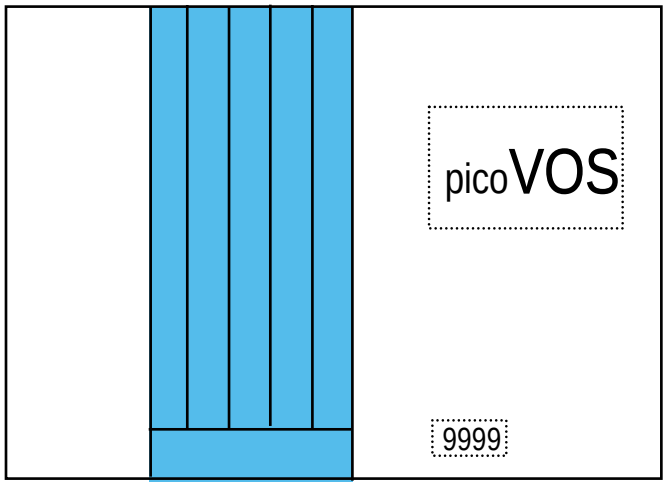
Tech: Save Block RAM

- **Only store necessary data**
- **Screen contains three display modules and black background**
- **Solution:**
  - Black background need not be stored
  - Every display module only uses one color



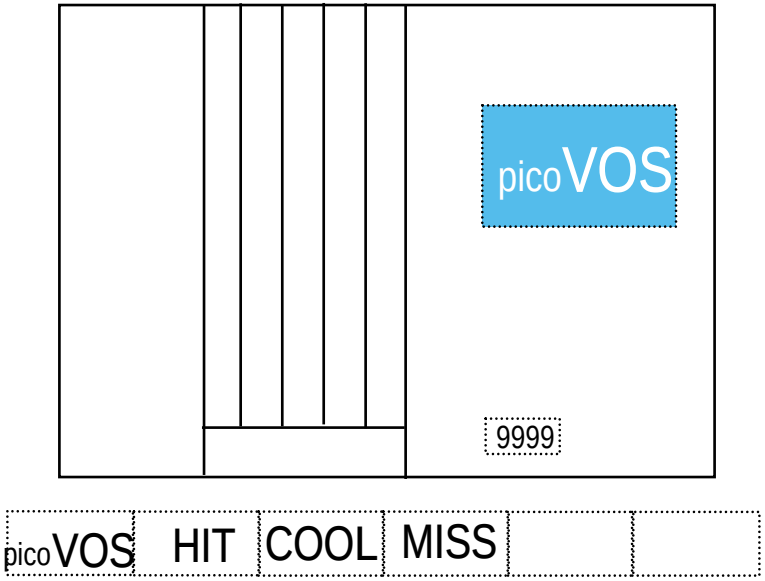
Tech: Save Block RAM

- **VGA_RAM**
  - Display area: 224 pixels x 480 pixels
  - 7 columns, display content in every columns are the same
  - Every column one color, controlled by hardware, not memory
  - Necessary memory size: 7x480 bits
- **Solution:**
  - Size: 4096 x 1bit – One Block RAM
  - PortA: PicoBlaze Write
  - PortB: VGA read
  - Address Width: 12 bits
    [2:0] – VGA horizontal pixels
    [11:3] – VGA vertical line number

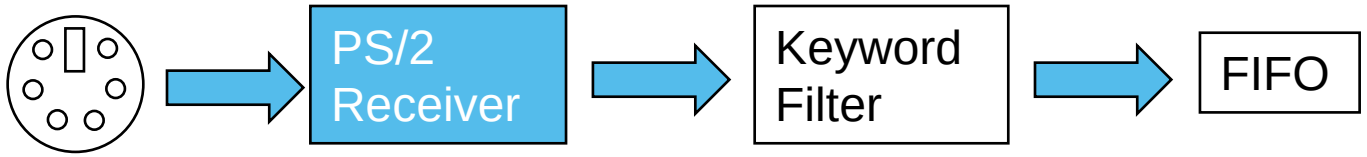


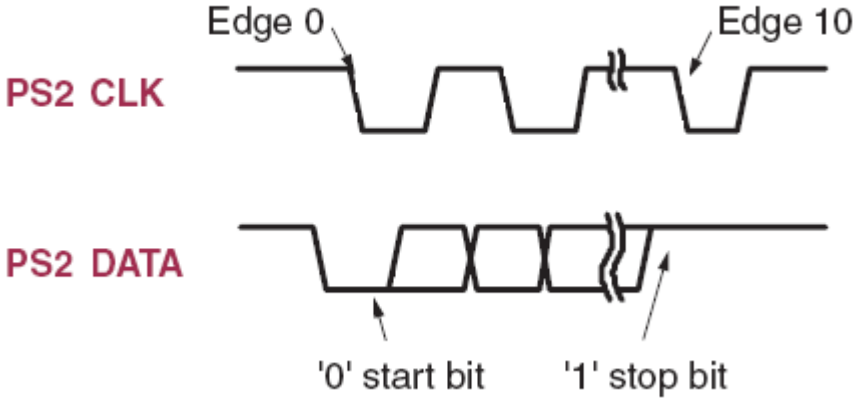
Tech: Save Block RAM

- **LOGO_RAM**
  - Display area: 128x64 pixels
  - Display picoVOS logo and game status such as “HIT”, “Cool” and “Miss”
  - Designed to store 6 pictures; this game uses 4
  - Pictures have different colors, but do not use memory to store color info
- **Solution**
  - Size: 6x128x64 = 48kb = 3 Block RAM
  - PortA: 1.5k x 32bit for ease of init value definition in COE file
  - PortB: 48k x 1bit
  - ADDRB:
    [6:0] - 128 bits complete a line
    [12:7] - row number
    [15:13] – choose a picture



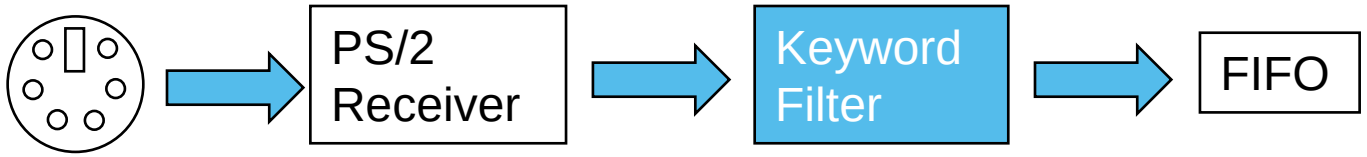
Tech: Keyboard Driver





Trig Data on the
Falling Edge of PS2 CLK
-Start Bit: 0
-Stop Bit: 1
-Parity Bit: one bit

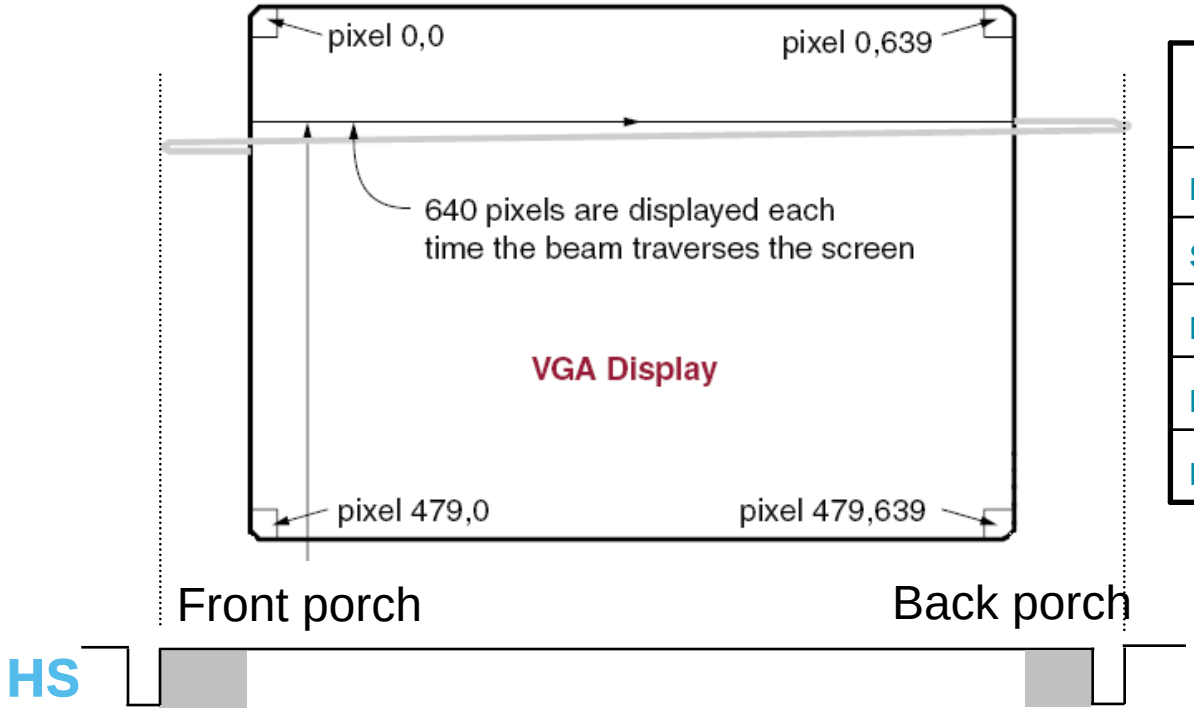
Tech: Keyboard Driver



-Type A in Keyboard

- PS/2 Receiver get: 1C F0 1C
- Keyword Filter output: 1C

Tech: VGA Display



	HS Clock	VS Lines
Display time	640	480
Sync pulse Time	800	521
Pulse width	96	2
Front Porch	16	10
Back porch	48	29

VS acts the same, but vertical