

# Javier Valcarce's Homepage

*Published: 2007-08-15*

*Updated: 2007-08-15*

## VGA Video Signal Format and Timing Specifications

### Summary

This page explains VGA video signal format and its timing for the different video modes.

### VGA Video Signal Format

A color VGA video signal is composed by 5 different signals: two synchronization signals (HSYNC and VSYNC) and three color signals (R, G, B)

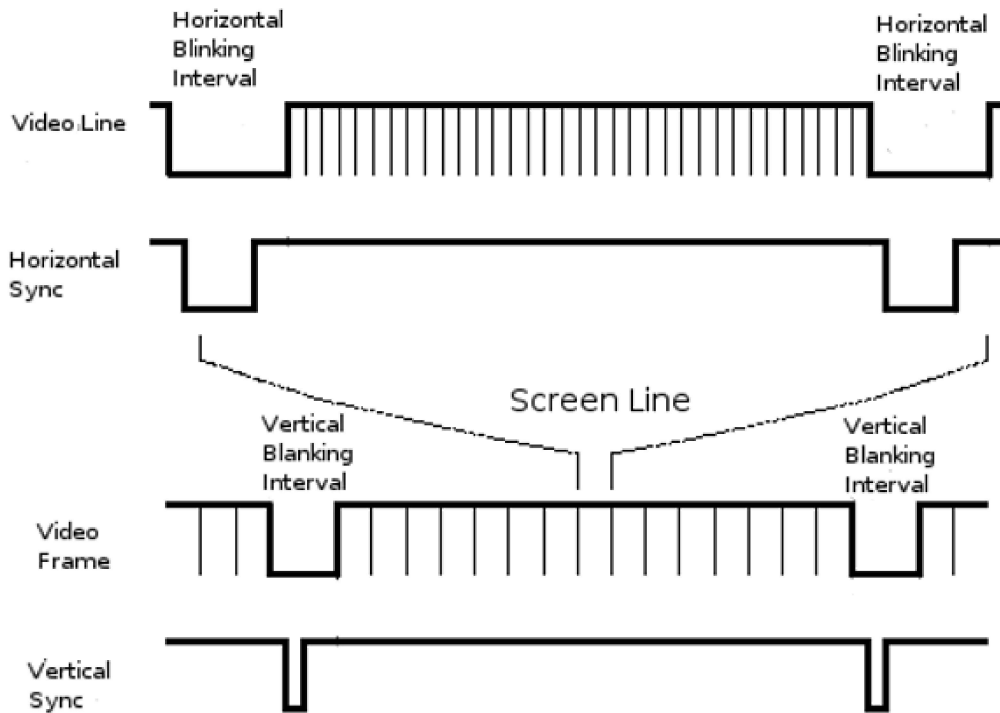
<b>HSYNC</b>	Horizontal sync. Make electron beam restart at next screen's scanline (starts a new line).	HSYNC and VSYNC signals determine the screen resolution (for example 640x480)
<b>VSYNC</b>	Vertical sync. Make electron beam restart at first screen's scanline (starts a new frame).	
<b>R</b>	Red intensity.	
<b>G</b>	Green intensity.	
<b>B</b>	Blue intensity.	

whereas the colour of every pixel is determined by the value of R, G and B signal. Each color is a combination of the 3 primary colours R, G and B.

HSYNC and VSYNC signals are a train of squared pulses of +5V (+3.3V serves too) whereas RGB signals take values in a continuous (analog) voltage range from +0V (absolutely dark) to +0.7V (maximum brightness). Each of this 3 signals controls a electron gun that makes the screen's phosphor bright a basic colour (R, G or B) in a pixel. Any colour is the visual mixture of different levels of brightness of the 3 primary colours.

A single dot of colour on a video monitor doesn't impart much information. A horizontal line of pixels carries a bit more information. But a frame composed of multiple lines can present an image on the monitor screen. In a 640x480 mode, for example, a frame of VGA video has 480 lines and each line "usually" contains 640 pixels (see later).

In order to paint a frame, there are deflection circuits in the monitor that move the electrons emitted from the guns both left-to-right and top-to-bottom across the screen. These deflection circuits require two synchronization signals in order to start and stop the deflection circuits at the right times so that a line of pixels is painted across the monitor and the lines stack up from the top to the bottom to form an image. The timing for the VGA synchronization signals is shown in Figure 2.

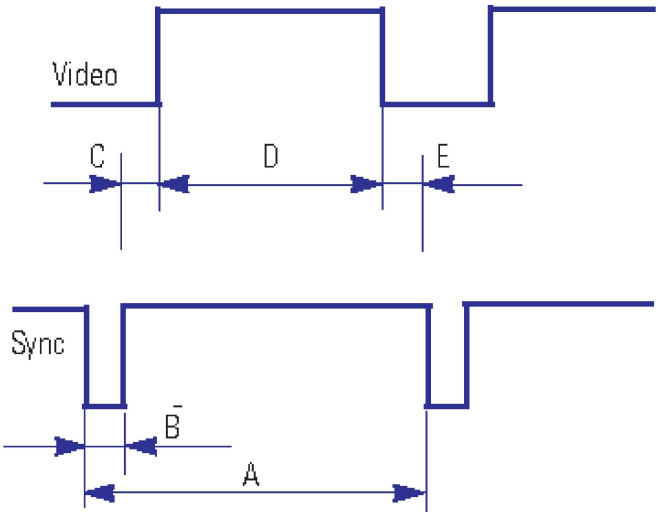


- Pulses on HSYNC signal mark the start and end of a line and ensure that the monitor displays the pixels between the left and right edges of the visible screen area.
- Pulses on VSYNC signal mark the start and end of a frame made up of video lines and ensure that the monitor displays the lines between the top and bottom edges of the visible monitor screen.
- As you may have guessed, the horizontal resolution of each line "is not actually determined" and could be anything, this resolution is determined typically by a "pixel clock". Every rising edge of the pixel clock marks the start of a new pixel.

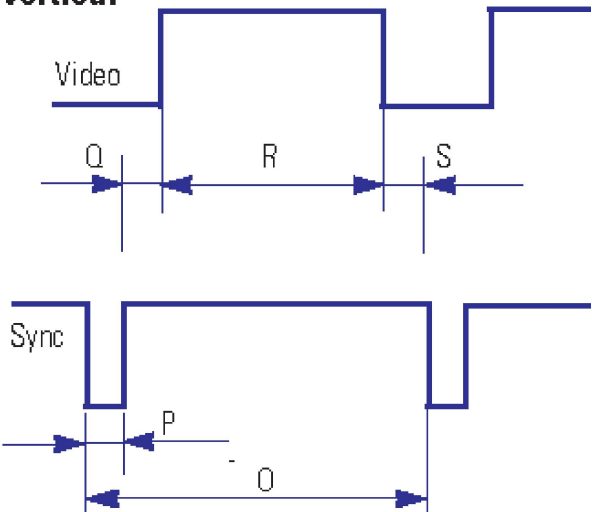
## Video Modes and Their Signal Timings

The following table shows the time restrictions that video signal must obey in order to the monitor can synchronize and displays the image correctly (without blinks). The pixel clock frequency is only orientative, when designing a video hardware, you can use the pixel clock frequency that you want, the only important thing is that the video signal fits with the time restrictions (measures A, B, C, etc).

Horizontal



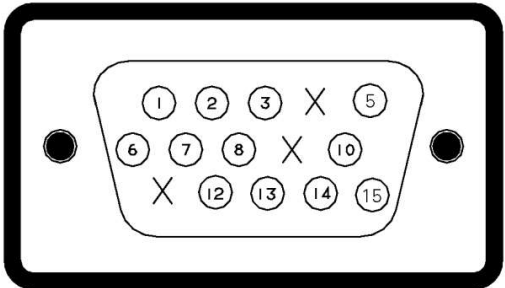
Vertical



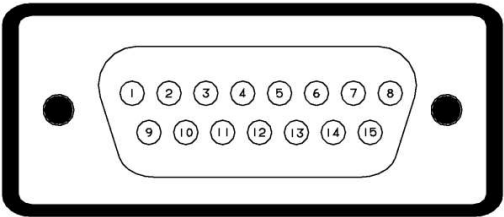
Analog Video Signal Timing Specifications

Measure	Unit	IBM		VESA					
		640x480 60Hz	720x400 70Hz	640x480 75Hz	640x480 85Hz	800x600 75Hz	800x600 85Hz	1024x768 75Hz	1024x768 85Hz
F_HSYNC	kHz	31.469	31.469	37.500	43.269	46.875	53.674	60.023	68.677
A	us	31.778	31.777	26.667	23.111	21.333	18.631	16.660	14.561
B	us	3.813	3.813	2.032	1.556	1.616	1.138	1.219	1.016
C	us	1.907	1.907	3.810	2.222	3.232	2.702	2.235	2.201
D	us	25.422	25.422	20.317	17.778	16.162	14.222	13.003	10.836
E	us	0.636	0.636	0.508	1.558	0.323	0.589	0.203	0.508
F_VSYNC	Hz	59.940	70.087	75.000	85.008	75.000	85.061	75.029	84.997
O	ms	16.683	14.268	13.333	11.764	13.333	11.758	13.328	11.765
P	ms	0.064	0.064	0.080	0.671	0.064	0.056	0.050	0.044
Q	ms	1.048	1.080	0.427	0.578	0.448	0.503	0.466	0.524
R	ms	15.253	12.711	12.800	11.093	12.800	11.179	12.795	11.183
S	ms	0.318	0.413	0.027	0.023	0.021	0.019	0.017	0.015
Pixel Clock	MHz	25.175	28.322	31.500	36.000	49.500	56.250	78.750	94.500
Polarity HSYNC		Neg	Neg	Neg	Neg	Pos	Pos	Pos	Pos
Polarity VSYNC		Neg	Pos	Neg	Neg	Pos	Pos	Pos	Pos

VGA Connector



PC connector (DB15)



Macintosh connector

*Pinout. "NC" means "No Connect"*

Pin	PC (DB15 connector)	Macintosh
01	Red	GND-R
02	Green	Ref
03	Blue	H/V-Sync (not separate sync)
04	NC	Sense 0
05	DDC Return	Green
06	GND-R	GND-G
07	GND-G	Sense 1
08	GND-B	Reserved
09	NC	Blue
10	GND-Sync/Self Raster	Sense 2
11	NC	GND
12	DDC Data	V-Sync
13	H-Sync	GND-B
14	V-Sync	GND
15	DDC Clock	H-Sync

## References

- [VGA Signal Generation with the XS Board](#)
- [Pinouts.ru](#)

*This page forms part of website <https://javiervalcarce.eu>*